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"GIVE SCIENCE A CHANCE"*

INTRODUCTION

AFTER referring to the sad loss which the country has suffered by the death of Acharya Ray, Sir S. S. Bhatnagar described the visit of Prof. A. V. Hill as "Perhaps the most outstanding event in the scientific life of India during the past year". The invitation to Professor Hill extended by the Government of India has been generally taken as an indication of their interest in securing the aid of science to problems of national development to which they are committed during the post-war period. It was largely owing to the insistence of the Council of Scientific and Industrial Research that more financial aid should be given to science, that such an invitation could be conceived even during the war.

Proceeding, he said, "It is a happy augury that the report made by Professor Hill had an unusually short incubation period. Following his recommendations the Government of India have already created a Department of Planning and Development and the Council of Scientific and Industrial Research has been transferred to this portfolio. Other research activities under the Government are likely to follow suit. I am sure the scientists assembled here have special reason to be happy in the fact that the choice of the Viceroy for the care of this new portfolio has fallen upon Sir Ardeshir Dalal who has been a past-President of the Indian Science Congress and who commands the confidence and respect of the scientists as well as of the business community of India. It is hoped that other far-reaching recommendations of Professor A. V. Hill will also be accepted by the Government of India. There is no better method of raising the standard of science and scientists in this country than that so ably developed and skilfully described in his address before the last session of the Indian Science Congress.

"Another direct outcome of Professor A. V. Hill's visit to India has been that a mission of scientific workers from our country has been touring the U.K. and has arranged to go over to the U.S.A. and Canada, to observe the scientific, industrial and agricultural developments which have come about in these countries during the war and then to make recommendations and suggest plans for a further interchange of information and knowledge for mutual help and co-operation. India has been cut off intellectually for more than five years from the rest of the world and that in itself is a disaster the magnitude of which is directly proportional to the vast strides science and research have made in the U.K. and the U.S.A.

"My present visit to England has been the greatest eye-opener to me and I have now seen with my own eyes the high levels to which scientific invention and ingenuity have risen during the war. Not only has science helped

* Extracts from the Presidential Address by Sir Shanti S. Bhatnagar, Kt., O.B.E., D.Sc., F.R.S., to the 32nd Annual Session of the Indian Science Congress, held at Nagpur, on 2nd January 1945.

in developing weapons and instruments which are essential for success in a mechanical warfare, but it has aided industry and agriculture in supplying the basic needs of humanity during a period of great difficulty. The results both in military and human terms have been most encouraging. The large-scale application of radio-location, the jet-propelled planes, the numerous types of jettison tanks and unbreakable containers, the automatic weapons of offence and defence and scores of new alloys and novel metallurgical processes have had far-reaching consequences on the course of the war. The technique of operational research, the use of scientific methods of determining tactics and developing a national food policy, the discovery of penicillin and D.D.T., all these have contributed much to the realisation by the common man and the Government that organised science is one of the most important factors in national development. It is a tragedy that a ruthless war and almost universal bloodshed should be necessary for this new awakening, for it should have been obvious without it that science can play and must play an essential part for human advancement. In fact, unless opportunities are provided for science to explore these possibilities for human betterment, a better world cannot be created.

"There is no doubt that England is sparing no effort to approach the Peace much better informed and equipped than after the last War and the signs of this new awakening are visible in the universities, the Government departments, in industry, the agricultural and medical institutions and in every other walk of life."

Science in the British Universities

"We found most Universities denuded of their ablest workers. They were nearly all engaged in important war work and visited their departments only occasionally. They were busy with meetings and committees and in special scientific work related to the war-effort: but all the same they are all devoting their attention to the future of science in British Universities. The Association of Scientific Workers has submitted a memorandum to the University Grant Committee of the Treasury suggesting what reforms in teaching and research should be taken in hand immediately after the war and better provision for science should be made in the universities. Their report ends with the following strong plea:

'We reiterate, then, our plea for the utmost vision and flexibility in budgeting for the development of science in the Universities. Where the flowering of intellect is concerned, any accurate prediction is impossible. We are convinced, however, that peace can see at least as rapid a growth in all fields of science as war has brought about in some special applications. The only proper attitude for an enlightened community is to make available the financial and material resources appropriate to each stage of development. We are far from being in sight of either the limits of science or the end of our reserves of intelligence. Bold and flexible thinking is, therefore, the prime necessity in framing post-war policy for the universities.'

"Out of the many important recommendations made by the Association of Scientific Workers for the expansion of scientific activities in the universities, the following are quoted so that the Indian universities may take a lesson from what is now the train of thought in Great Britain:

(1) Schools of fundamental research must be fostered in the universities, expansion proceeding as fast as talent appears.

(2) All graduates with an aptitude for research should be offered full maintenance while working for a higher degree.

(3) Research fellowships should be provided for those who have taken a Doctorate degree.

(4) When men are appointed mainly to do research they should have the same status and salary as those appointed mainly for teaching.

(5) Research committees should be set up in every university to watch over the development of research, especially in borderline subjects, and prepare an annual research budget.

(6) The education and training of laboratory technicians should be given immediate attention. Courses should be planned for general education and technical training.

(7) The wages of technicians must be revised upwards forthwith if the universities are to attract the right type of personnel.

(8) Centralised technical services and supplies for research should be established in each university. These should include facilities such as a typewriting pool and a statistical service.

(9) Departments of applied science should be brought into being, as they are bound to play an important part in the university.

(10) Industrial development work should be carried out in Research Association laboratories: but where these Research Associations do not exist the university laboratories may be employed.

(11) Academic scientists should be allowed to act as consultants or advisory directors of research to research associations and should be given leave to spend long vacations in industrial laboratories.

(12) Properly supervised research in selected Research Associations and Government laboratories should be allowed as part of or a full qualification for a higher degree.

"Some of these recommendations involve capital cost and the memorandum referred to above estimates this to be not less than £30 million over a period of ten to twenty years. The actual expenditure of the universities would rise to £15 million per annum within five years and to £20 million over ten years at 1939 values. It has been suggested that most of this money will come from the State. Further, it has been strongly recommended that the Treasury Grant to the Universities should be doubled in the first academic year after the war and increased to quadruple, that is, to £9 million, in the fifth year.

"The future of science in the British Universities would thus be assured. This must serve as an incentive to our Vice-Chancellors who should ask the nation and Government for more grants for technical education and developments of sciences in the Indian universities. I have been told that at least in two Universities in India, scientific research is now positively discouraged and (in the name of economy) admission to research students, in spite of the willingness of the professors concerned, is almost completely prohibited. I take this opportunity of drawing the attention of those who love their country and wish it well to see that the field of University education is kept as free from narrow communalism and politics as possible. Since politics has begun to play a part in the selection and election of Vice-Chancellors, the University standards in India have tended to deteriorate instead of showing an improvement and if these evils are not looked into by the Chancellors and the Courts of the Indian Universities, these institutions will cease to be real seats of learning and will turn into arenas for political ambitions."

Science in British Industry

"British industry in the past relied too much on tradition. It is now realised that the prosperity of Britain after the war will depend as never before upon the efficiency and progressiveness of her industries. Happily, for it is a most healthy indication of things to come, industrial and scientific research, is on almost everyone's lips now-a-days and it is certain that this will be one of the major features in post-war industry. In certain industries, such as the chemical industry, the application of science and research has reached such high levels already that even the Department of Scientific and Industrial Research has not considered it an imperative necessity on their part to equip and maintain their Chemical Research Laboratory to the same level of efficiency as their National Physical Laboratory. They maintain that the Imperial Chemical Industries conduct research on such a large and liberal scale that the Government Laboratories need not compete with them. The Directors of the Company are progressive in their views on scientific development and at a luncheon which the I.C.I. gave to the Indian scientists at Claridges, Lord McGowan, the Chairman, reported that the Directors of the Company had offered to provide at nine Universities of Great Britain, eighty fellowships of the average value of £600 per annum to be held by senior workers in certain sciences. The research organisation of the Company itself consists of nearly nine hundred fully qualified chemists, physicists, biologists, engineers and other scientific men and more than a thousand skilled assistants. During 1943 its expenditure on research and development in its own work was approximately £2,200,000; and in addition, £12,500,000 became due from the Company to the British and Overseas Governments under the heading of Excess Profits Tax, National Defence Contribution and income-tax. We had the good fortune to see their vast factories and research organisations at Bellingham, Blackly and Huddersfield, and our distinguished industrialists who are visiting England should go and see these signs of research-mindedness of the British Industries.

"When I replied to the toast proposed by Lord McGowan at the luncheon, I spoke of the I.C.I.'s partiality to their own country. They had at least two big factories in India and I pleaded for grants on a generous scale for scholarships for scientific research in India by the I.C.I. I urged that no feast given to the Indian Brahmins is complete without a gift, and that all scientists are Brahmins by profession. The plea went home to Lord McGowan and he promised to consider in a friendly way the question of endowing research fellowships in Indian Universities. He also assured us that the eighty fellowships in the British Universities were open to Indian scientists in free competition.

"Besides the I.C.I., there are other industries in Britain which have large research departments, and we were particularly impressed by the efforts which had been made by such firms as Metropolitan Vickers at Trafford Park, Manchester, by the General Electric Company at Wembley, by Burroughs Wellcome, by Brown Firth & Co., by the B.T.H. at Rugby and by the Anglo-Iranian and Shell group organisation. In addition to the many private investigations carried out by individual firms, the interests of research by industry are safeguarded by investigations carried out in twenty-four Industrial Research Associations, which are maintained jointly by Industry and the Department of Scientific and Industrial Research."

"We are aware of even more outstanding organisations of this kind in the U.S.A. and Canada and look forward with eagerness to visiting the Bell Telephone Laboratories in New York in which the American Telegraph and Telephone Company employ over 4,000 scientific workers and technical men. The General Electric Company at Schenectady, N.Y., the Eastman Kodak Company at Rochester, N.Y., the Mellon Research Institute, Pittsburgh, and the various Petroleum Companies in the U.S.A. have fully equipped laboratories which work day and night on problems of fundamental and applied interests.

"If Indian industry has to rise, and rise it must to its proper stature in time, it must begin to devote more attention to expenditure on research. There is hardly any industrial organisation in India except Tatas which provides even reasonable facilities for scientific and industrial research. Lately Mr. G. D. Birla and Sir Shri Ram have shown some interest in scientific research, but much has yet to be done by science to save the existing industries in India from extinction by outside competition after the war.

"The newly started industrial units of India should join together and form Industrial Research Associations and the Council of Scientific and Industrial Research and the Government should subsidise the organisations so that they may blossom forth into hopeful industries of the future India.

"Now that expenditure on research, both

capital and recurring, is likely to be free from the Excess Profits Tax, Indian industry should give a real impetus to science. Nothing will help industry and science more than if our firms in India become research-minded. Even before my visit to England I strongly advocated the formation of Research Associations in India and I am glad to hear that the chemical and pharmaceutical industries of India are about to give a lead in this matter and have apprised the Council of Scientific and Industrial Research of their intention to form a research association. After seeing the work of Research Association Laboratories here, I have become convinced that we must work hard to get our small and big industries in India research-minded so that they may gain knowledge and strength to produce goods of the best quality and performance."

INDUSTRIALISATION OF INDIA ESSENTIAL FOR WORLD PROGRESS

"Perhaps the most important factor which will have world-wide implications will be our attempt to raise the standard of living in India. Politics does play an important part in all events. It is obvious that the best and quickest way of bringing about national development is for India to have a National Government representative of the people. The present absence, however, of such a government does not justify that the thinking men and women of India should not devise ways and means of bettering the lot of their fellow-beings to the best of their ability under present circumstances and in view of the future. I am not convinced that the rich and the wise in the land have done all they can for agricultural and industrial development of India.

"It has been urged by some that the problem of India is largely biological: that health, food and population are our real bottle-necks. Those who know India intimately are fully aware of the facts that attention to agriculture alone cannot solve the problem of India's poverty. Biology must be helped by physics, chemistry and engineering, even by mathematics. India cannot be healthy, prosperous and self-respecting, and education, medicine, and agriculture cannot play their important role, unless a good bit of India's population is devoted to pursuits other than agricultural.

"In a previous paper I have described the orders of priority for some of the industries essential to India's development. In that paper the first place was given by me to the development of power and there seems to be now a general consensus of opinion that India must develop her hydraulic and other power resources as her coal resources are already severely strained. This project will have to be largely financed by the State, as it is far too big for any private enterprise in India. The State will also have to help big basic industries and heavy engineering. We should, by all methods of persuasion and even threats, appeal to the existing industries in India to develop the bye-products industries associated with them. For example, the great jute industry in India should take immediate steps to manufacture such things as jute-boards, Brattice cloth, jute felt from jute waste, jute containers and jute cloth for wearing purposes. The State and the public should insist upon these industries being developed by the jute industry itself. Similarly it should be the duty of the sugar industry that their bye-products such as molasses and bagasse should not be used wastefully as at present. Power alcohol, furfural and its derivatives, acetic acid and all sorts of plastics and solvents can be made from these bye-products and these should occupy the immediate attention of the promoters of our sugar industry. They have sufficient money to invest in these ventures which may not start paying dividends all at once, but they will eventually be all very worthwhile in national planning and development. If I would not be misunderstood, I would make a suggestion to those European and Indian friends who are interested in the industrialisation of India not to fight for less or more to either side, but to come to terms honourable for both and do something to help Indian industry. It is obvious that European friends in India will have to yield to the natural aspirations of India, namely, that industry in India should be largely managed by Indians themselves. Indian businessmen should see that co-operation with the allied powers is the quickest method of developing India. The energy spent in fighting may be better spent in co-operative development. If the bye-product industries of coal-distillation, the petroleum industry, the textile industry, the woollen, cotton, sugar and jute industries and the metallurgical and chemical industries are developed, the country will have a different complexion altogether and a co-ordinated programme of development in all directions will become a possibility. This plea I am entitled to make as President of the Indian Science Congress, as I am convinced that science has no future in India unless our agriculture and our industries are fully developed; more food and more health are dependent upon these factors. Scientific and industrial research thrives best when it is applied to material benefit to human kind and to existing industries and existing agricultural enterprises."

TRAINING OF PERSONNEL

"As a result of our visit it may be possible to persuade the Government to have scientific liaison officers in Washington and London, and possibly in Moscow, so that the Indian scientists and the Indian Government departments may be in touch with the rapid strides which Science and Technology are making in these countries. These offices will have to be staffed by scientific men of some standing in India. It is also likely that we may be able to get admission for a large number of scholars and technicians from India both in the Universities and industries. We found many Universities eager to have good students for post-graduate studies. Lord Eustace Percy was particularly anxious that good-class Indian students should take advantage of medical and dental studies in their well-equipped faculty of medicine at Newcastle. Similar assurances were given to us by the authorities of Cambridge, Oxford,

London, Sheffield, Leeds, Glasgow and Manchester Universities. There will be a great paucity of space immediately after the war in these places of learning, but they hope to have a great deal more space later on. We should increase the availability of technical talent in India by sending our young and brilliant students to England and America. India needs not only scientific researchers but also technicians—persons of the foreman type who can help in the running and repairs of machinery so essential for industrialisation. Such firms as the Imperial Chemical Industries, Metropolitan Vickers and the non-ferrous metal industries in England are quite willing to train young men from India and even pay them as apprentices; we need a very large number of men with these qualifications, and we shall have to look for such training in Canada and the U.S.A. as well."

FACTORY AND FARM

"In England great emphasis is being laid on equalising the standard of life in the cities and the villages. Agriculture still retains in England too much of its primitive character. Modern methods of application of energy on the farms, conditioned transport and proper storage of agricultural produce are still in their infancy. Canada and the United States are ahead in this field and the tractor, the motor vehicle and electric power have contributed a great deal in those countries for a better standard of life on the farm. On a value basis at present about 88 per cent. of the world's agricultural produce is used as food, 8 per cent. as textiles and 4 per cent. for other industrial purposes. The last two together form roughly one-third of the raw materials of industry. There is an increasing tendency to look to agriculture for a larger proportion of these raw materials, but these materials can only be used profitably if the factory becomes an adjunct of the farm. Industry is moving towards that ideal particularly in the U.S.A., and this may be a lesson which we in India may learn in our planning for the future. We are so primitive in our farming that this would be an idle dream unless we first improved our transport and communications and provided better methods of storage and marketing, power-driven machinery and the use of proved fertilisers."

Concluding the President described the Tennessee Valley enterprise as "the romance of a wandering and inconstant river, now become a chain of charming and lovely lakes which have contributed much to the enjoyment of life of the people, on which move, without any dangers of accidents, barges of commerce which nourish American industries. It is a fairy story of wild waters controlled by human ingenuity creating electrical energy which has been America's Alladin's lamp. I dream of the Tennessee Valley, but not without hope: for all this may happen to any river valley in India to the Damodar, to the Ganges, to the Sutlej, to the Narbada, to the Sone, if the people and the Government just give science a chance."

THE NEW OIL COMMITTEE AND FUNDAMENTAL RESEARCH

IT is a matter for sincere gratification and happy augury for the future welfare of the millions of this country that the Government of India Member for Health, Lands and Education should have recently declared his firm conviction before an assembly of the representatives of trade and commerce at Madras, that the promotion of the health and education of the people and the development of the resources of the country are of "greater importance than political problems". This advice and the appeal made by Sir Jogendra Singh, himself a producer, to an assembly of commercial magnates is none too early at the present juncture of our national economy. In any self-governing country, the merchant class should consider themselves not only as the privileged distributors and trade agents of the national produce but should also act reciprocally as the enlightened patrons promoting the cause of the producers. Production requires not only the capital of the business-man but also the wholehearted co-operation and contribution of the skilled technician and of the research scientist.

The idea of creating commodity committees and making them self-supporting to carry on research and have their own services throughout the country is an extremely useful and creditable suggestion. Among such commodities, the position of oil-seeds is a very high one indeed.

Not long ago *Current Science* had an editorial on this important subject putting in a strong plea for the scientific utilisation of Indian oil seeds. After a period of nearly two years it is encouraging to find that publicists have paid attention to the points urged therein. It is well known that oil seeds form a valuable part of the annually recurring agricultural wealth of this country. Out of a total area of 300 million acres under actual cultivation about 60 million acres are under oil-seed crops. Further the 90 million acres of Indian forests also yield as minor forest produce, commercial quantities of important oil seeds. The more abundant of these are listed below for convenience of reference.

Oil-seed	Area in millions of acres	Output in millions of tons
Cotton	25·0	2·0
Groundnut	10·0	3·3
Mustard and rape group	7·0	1·0
Linseed	5·0	0·5
Gingelly	5·0	0·6
Castor	2·0	0·2
Cocoanut	1·4	1·4
Poppy	0·5	0·2

The less abundant but nonetheless valuable commercial oil seeds comprising mowra, nigerseed, safflower, kokum, domba, dhupa, chaul-

mogra, neem, ritha, cashew, honge, kusum hemp and many others add to a total of about 10 million tons of oil seeds, approximately valued at 100 crores of rupees. The proper utilisation of this precious raw material not only in the best interests of the agriculturists but also in the interests of landless labour and the educated unemployed, is a responsibility which no enlightened government or patriotic business-man can shirk. A unique feature of oil seeds is their potential as well as actual utility for a variety of the essential needs of man, machine, livestock, and soil, as foods and drugs, as fuel, as fodder, as fertiliser, and for a variety of other industrial purposes.

A rational plan of utilisation of these oil seeds will naturally resolve into a systematic assessment of the scientific value and the industrial potentiality of the three components into which they may conveniently be separated: (1) The shells and husks of the oil seed, (2) the oils and fats derived from the kernels and (3) the residual oil-cakes. Each of these forms a valuable starting material from which a succession of industries could be built up. Taking first the most important components of them, *viz.*, the oils and fats, one need only peruse the following list of their industrial uses for realising their vast and varied importance.

(1) Refined salad and edible oils, including hydrogenated vegetable ghees, (2) toilet, textile and liquid soaps including Turkey-red oils, (3) illuminating oils, candles and liquid fuels, (4) glycerine and explosives, (5) paints, varnishes, lacquerware and plastics including rubber substitutes, (6) shoe and leather-dressing greases and polishes, (7) simple and compound lubricants, (8) linoleum and water-proof fabrics, (9) medicinal oils and pharmaceutical compositions, (10) various fine chemicals including valuable synthetic perfumes.

Each one of these uses has led to the development of a special branch of oil technology. The progress attained so far in each of these, however, has been based chiefly on imitation of experience gained outside India, and as such suffers from being too wooden and static to inspire continuous research on them so as to ensure a progressive efficiency and economy. For example the oil hardening and vegetable ghee industry has factories all over the country where some of the foreign formulæ are imitated in specially imported foreign machinery, affording neither incentive nor encouragement to creative research in this field of chemical industry. For instance other catalysts than nickel can certainly be found to effect hydrogenation of oils. To take another example, other oils than castor may be treated so as to yield Turkey-red oils. Again, satisfactory liquid fuel for lamps as well as for engines can be made from cheaper vegetable oils by suitable cracking processes or by other chemical treatments. Another important branch of oil technology in which commercially valuable results are possible by systematic research is the production of candle material and wax substitutes from most of the common oils by special hydrolytic or oxidative methods. In a similar way many common semi-drying or non-drying oils like castor oil or even groundnut oil can be converted by oxidative and dehydration methods into linseed oil substitutes for the purpose of the paint and varnish industry. In fact the scope for fundamental research leading directly to results of industrial value is almost unlimited in every branch of oil technology. The above examples are only a few illustrations of such possibilities.

One of the most attractive and in the writer's opinion the most outstanding contribution which applied chemistry can make to oil technology will be the establishment in this country of a genuine synthetic ghee industry. It will be an achievement alike for the chemist, the technologist, the industrial captain, and the administrator if they will co-operate through an industrial research laboratory to make this a commercial success. It will mean firstly the establishment of a fatty acid key-industry employing either fermentation methods of hydrolysis of oil or the more drastic hydrolytic methods of oil splitting by caustic alkalis or mineral acids. In both these cases glycerine liquor will be a concomitant bye-product, and the production of pure glycerine from this bye-product will be the second stage of the future synthetic ghee industry. The third stage will consist of the esterification with pure glycerine of the various fatty acids mixed together in the right proportion as found in genuine cow's ghee or buffalo-ghee or goat's ghee so as to effect thereby the formation of a genuine ghee by purely synthetic methods. Accessory food factors like vitamins, sterols and colouring matters may be added to this product to make it perfect as a genuine substitute of ghee.

Turning next to oil-cakes it is needless to emphasise that the utility of oil-cakes not only by themselves but as raw materials for further chemical industries is almost unlimited. Many of them are capable of yielding by suitable methods of extraction, hydrolysis, or other chemical treatments a variety of useful industrial products in the form of fatty and protein foods, as medicinally valuable glucosidic alkaloidal and resinous drugs, as detergents and soap substitutes and as adhesives and glue ghee substitutes besides affording mineral constituents like phosphates and potash salts as rich fertilisers. In fact there is a crying need for a systematic chemical research on the scientific and industrial potentialities of our abundant oil-cakes. It is rather difficult to foresee in full the immense possibilities in this direction. It is permissible to add in this connection that even a fine chemical industry involving a series of amino-acids on the one hand and sterols, phosphatides and related compounds on the other, is possible of establishment by using oil-cakes as starting material.

Coming last to the shells and husks of oil seeds the position regarding the scientific knowledge about them is even more scanty than that of oil-cakes. Many of them contain valuable colouring matters, tannins and carbohydrates and cellulosic materials of various types, besides being rich sources of valuable potash and phosphates in their ashes. At present they are either burnt off as cheap fuel or in rare cases used as adulterants

of doubtful fodder value. The proper industrial exploitation of our oil-seed shells and husks is yet to be thought out. To indicate the possibilities in this direction one may refer to a few that have yielded useful industrial products as a result of systematic scientific research. It is well known that cocoanut shells are rich sources of phenol and acetic acid on their being subjected to destructive distillation. Similarly cashew shell oil which is a bye-product in the cashew industry on the west coast of South India is a rich source of higher phenolic compounds capable of yielding valuable plastic material on suitable treatment. The case of cotton seed hulls is another instance of hidden wealth brought out to light by systematic investigation. The hulls have been shown by the writer to be a very rich source of the valuable chemical substance, *viz.*, furfuraldehyde which is readily optained from it by a simple hydrolytic treatment. The utility of furfuraldehyde in the synthetic plastic industry as well as in the synthetic dyestuff industry is well known. Further the ashes of cotton seed hulls are almost entirely composed of potashes, which are so useful in the fertiliser industry. The hulls also yield a dyestuff which can colour silk or cotton yellow. The case of groundnut shells is very similar to that of cotton seed hulls, and can yield the same products besides pure alpha cellulose. Another direction in which the shells can be utilised is for the preparation of active carbon. It may be said in general, therefore, that a systematic investigation into the scientific and industrial value of the immense quantities of the oil-seed shells and husks is almost an unexplored field full of industrial potentialities and will repay severalfold any amount of investment in the cause of their scientific investigation.

The above are only a few illustrations of the great industrial possibilities arising from a systematic scientific research into the industrial utilisation of our oil seeds and oil-seed products. It is not an exaggeration to say that if properly utilised the raw oil seeds of India may form a starting material capable of yielding a variety of useful finished products not in any way inferior in importance or utility or wealth to the products of the well-established coal-tar industry in India or elsewhere.

In carrying out the above schemes of research it is necessary to emphasise that a number of co-ordinated Provincial institutions, devoted exclusively to locally available oil seeds will be more useful than a centralised institute in any one part of the country. Equally important with these is the provision that will have to be made for the training of skilled artisans and scientific workers for a periodical demonstration and dissemination of the results of research among the interested public through the medium of local vernaculars. It is only by such increase of Indian scientific man-power among the middle class intelligentsia of this country through vernacular education that we can gather the moral and social momentum necessary to raise our country to the vanguard of the progressive nations of the world.

Our greatest hopes, therefore, lie in the new Vegetable Oil Committee which the Government of India have wisely helped to constitute at a most opportune moment in the history of our country.

P. RAMASWAMI AYYAR.

Note.—The cost of printing this article has been met from a generous grant-in-aid from the Imperial Counci of Agricultural, Research, New Delhi.

INFLUENCE OF MERCURY ON INSECT EGGS—PART I

BY B. KRISHNAMURTI AND M. APPANNA
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THE use of mercury for the protection of stored pulses from insects is an age-old practice in Mysore. Kunhi Kannan (1920) first brought this to the notice of Entomologists in India and elsewhere. He also found that the eggs of the pulse beetle, *Bruchus chinensis*, failed to develop and hatch in the presence of mercury. Larson (1922) made similar tests and confirmed this finding. Dutt and Puri (1929) later found that mercury was equally effective in arresting the multiplication of the grain weevil, *Calandra oryzæ.* Gough (1938) working on the flour beetle, *Tribolium confusum*, showed that mercury had a deleterious effect on the eggs while the grubs remained unaffected. Recently, Wright (1944) carried out observations about the effect of mercury on the eggs of other stored grain insects.

This note embodies in brief the results of a series of experiments conducted here to elucidate certain important details of the influence of mercury on the eggs of stored-grain insects. The aim of these experiments has been to fix the exact quantities of mercury and the methods of using it finally in the case of large-scale storage of grain.

TECHNIQUE

In all the experiments, tall and empty cylindrical jars of known volumes were used. Known quantity, by weight, of mercury was exposed in open paraffin crucibles of uniform dimension and thickness. These were kept at a height of 2·5 cms. above the level of the eggs arranged in a single layer, on filter paper in a petri dish. One hundred fresh eggs were taken for each experiment. The jars were kept covered with air-tight lids. Proper controls under identical conditions were maintained (Fig. C).

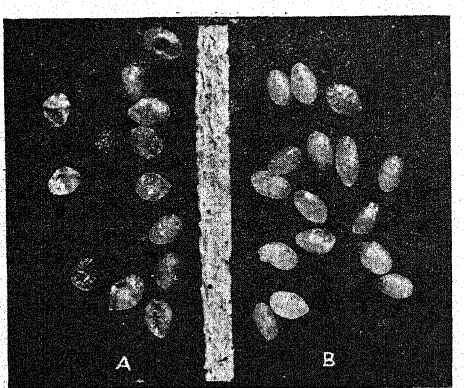
The time allowed to determine the effect of mercury was in each case twice the period taken for the larvæ to hatch out normally from the eggs in the control series. This period was considered necessary in order to allow time for any delayed hatching, in the experimental series.

(1) *Observed results of exposure of the eggs to mercury.*—Eggs (not older than 16 hours) of the following insects were tested: *Corcyra cephalonica*, *Bruchus chinensis*, *Calandra*

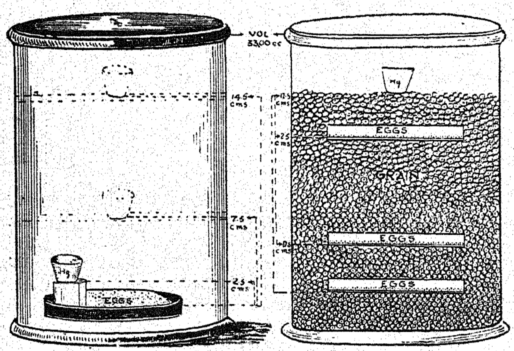
oryzæ, *Tribolium confusum*, *Rhizopertha dominica* and *Sitotroga cerealella*.

In all the experimental series the larvæ failed to hatch from the eggs even after double the period of time normally taken by the eggs to hatch in the controls.

For detailed observations the eggs of *Corcyra cephalonica* and *Bruchus chinensis* alone were chosen.



1. Eggs of *Corcyra cephalonica* exposed to mercury (A) and unexposed (B).



C D

2. Diagram showing the location of mercury and eggs in empty (C) and grain-filled (D) jars.

The eggs of *Corcyra cephalonica*, when exposed to mercury, underwent visible changes externally. Usually 48 hours after exposure, the eggs commenced to shrink; the internal contents also appeared shrunk and pushed to a side. The shining creamy-white colour of the eggs gradually faded. On account of the shrinkage a sort of depression on the exposed surface of the eggs was noticed four days after the first exposure; the colour of the eggs also turned brownish (Fig. A). About 3 per cent. to 6 per cent. of the exposed eggs of *Corcyra cephalonica*, however, did not undergo any perceptible change. The internal contents were found shrunk, but no depression of the surface chorion was visible. Such eggs were kept under observation for a longer period, but in no instance did any larvæ hatch out.

The eggs of *Bruchus chinensis* on exposure to mercury reacted similarly to those of *Corcyra cephalonica*. The eggs, which are usually glued to the grain by the female beetle, became shrunk and flat and gradually turned brown in colour.

Observations on the exact nature of the internal changes in the eggs are still in progress and not quite completed.

(2) *Effective (lethal) dose of mercury for particular volume of empty space.*—A series of trials was set up using different weights of mercury to find out the effective lethal dose for a particular volume of space. Fresh eggs of *Corcyra cephalonica* and *Bruchus chinensis* were used in these series. The technique adopted was the same as before, but the quantity of mercury used was diminished gradually from series to series. Two definite volumes, *viz.*, 3,300 c.c. and 4,000 c.c., were selected for this work. The following table gives the effect of different quantities of mercury on the eggs in particular volumes of empty space.

Quantity of Hg	Effect on eggs	
	3,300 c.c.	4,000 c.c.
1 gm.	Effective	Effective
·5 ,,	,,	,,
·1 ,,	,,	,,
·05 ,,	,,	,,
·03 ,,	,,	Not effective
·02 ,,	Not effective	,,
·01 ,,	,,	,,

The lethal dose was assessed to be that minimum weight of mercury which would be effective on the enclosed eggs in a particular volume of space. From the above table it could be seen that ·03 gm. of mercury is the minimum weight effective upto 3,300 c.c. and ·05 gm. upto 4,000 c.c. of empty space.

(3) *The relation between the age and stage of development of eggs and influence of mercury.*—A series of tests with the several post-embryonic stages of the eggs were made but none was found in the least affected. They developed normally into adults in the presence of mercury. The adults also behaved normally and lived their usual lengths of life. Copulation and egg-laying occurred without any visible hindrance.

To determine the exact age at which eggs were affected by mercury, the eggs laid by *Corcyra cephalonica* in wire-gauze oviposition cages were taken and at the time of their exposure to the mercury, they were not older than 16 hours. Different stages of eggs, between 16–48 hours were separately tested. Likewise, the eggs of *Bruchus chinensis*, laid on pulse grains 16 to 72 hours old, were tested.

It was observed from these series of tests that the eggs of *Corcyra cephalonica* less than about 24 hours old, only, were affected by mercury. Eggs older in age were not affected and larvæ later hatched out as in the control series. The eggs of *Bruchus chinensis* less than

about 48 hours old were affected and those older than 48 hours were not affected but hatched into larvæ. It was also observed that there was scarcely any reduction in the percentage of affected eggs as the age of the same advanced; in other words, the percentage of kill, due to exposure to mercury, of the eggs of *Corcyra cephalonica* and *Bruchus chinensis* less than 24 hours and 48 hours old respectively, was uniformly 100, whereas in the case of the eggs older than 24 and 48 hours respectively, it was also uniformly nil to two.

(4) *Mode of penetration of mercury vapour.*—The main object was to find out whether mercury vapour penetrated the egg through the micropyle or through the general surface of the chorion or through both. Eggs of *Corcyra cephalonica* and *Bruchus chinensis* (12 to 16 hours old) were selected and were painted with Euparol of a particular viscosity. In one series of tests only the micropylar end of the eggs was painted with Euparol. In another the entire general surface of the eggs excluding the micropyle was coated with Euparol. Proper controls with eggs painted with Euparol as in the corresponding experimental series, but without mercury, were maintained. In the control series larvæ hatched out in the same manner as in the case of normal and untreated eggs. (This incidentally also proved that Euparol had no ill-effects on the developing eggs.)

In the experimental series it was found that larvæ hatched out from eggs whose micropylar ends only were painted with Euparol whereas the eggs got shrivelled and shrunk in the case of those whose general chorion, excluding micropylar end was coated with Euparol. It appeared clear from this that mercury vapour penetrated the egg through the micropyle and not through the general surface of the chorion.

(5) *Time required for the action of mercury.*—As already stated above, double the period taken by the larvæ to hatch out normally was allowed to test the efficacy of mercury, on the several eggs exposed. Experiments were set up to study the minimum period required by mercury to kill the eggs. Fresh eggs of *Corcyra cephalonica* and *Bruchus chinensis* (12 to 16 hours old) were used in all these experiments. As before, the experiments were conducted in tall, air-tight and empty cylindrical jars (3,300 c.c. and 4,000 c.c.). It was seen that the eggs thus exposed to mercury for 24 hours and later continued in the same jar, but, with the mercury removed, were not at all affected. Eggs exposed to mercury for 48 hours and later removed from out of the jar into the open, became affected.

These experiments were repeated with the mercury placed at different elevations from the eggs spread out on the filter-paper in the petri dish; mercury was placed at 2·5 cms., 7·5 cms. and 14·5 cms. heights from the eggs (Fig. C) in the same jars and the same volumes of space; in each case after about 48 hours the eggs were found affected. It was thus seen that, for the same volume of empty space, the lethal dose of mercury affected the eggs at the bottom, equally effectively whatever the heights at which the mercury was placed.

The minimum period found required for the volatilisation of mercury—the lethal dose—(or for the required vapour pressure in a particular volume of space) and penetration of the vapour into the eggs to kill them in a particular volume of space, was thus about 48 hours.

In all the series of experiments mentioned here, the eggs and mercury were enclosed in the jars simultaneously. This procedure is slightly different from that adopted by other workers, who enclosed, not eggs but adult insects along with mercury. In the latter method there was sufficient interval between the time the adults were put in and the time the eggs were laid by them. During this interval a certain amount of mercury vapour already pervaded the interior of the receptacle. In the present series mercury commenced to volatilise only after the eggs were enclosed.

(6) *Effect of mercury in grain-filled space.*—The lethal dose of mercury found to be effective on the eggs in a particular volume of empty space was enclosed in the same volume of space (3,300 c.c.) filled with grains. Mercury was placed in the paraffin crucibles at the top of the grain. Fresh eggs of *Corcyra cephalonica* were kept at heights of 2·5 cms., 9·5 cms. and 12·5 cms. below the level of mercury (Fig. D). It was found that eggs kept at a height of 2·5 cms. below the level of mercury were affected while those kept lower down hatched out into larvæ. [As already noted in section (5)—in a series of tests with mercury placed at different heights in the same volume of empty space (3,300 c.c.)—it was found that mercury kept at the maximum height of 14·5 cms. above the level of the eggs was found to affect the eggs.]

(7) *Conclusion.*—From these observations it can be concluded—

(*i*) that mercury acts adversely on eggs of stored grains' insects; larvæ and adults, however, develop normally in its presence;

(*ii*) that eggs of *Corcyra cephalonica* and *Bruchus chinensis*, only about 24 hours and 48 hours old respectively are affected;

(*iii*) that ·03 gm. and ·05 gm. of mercury are the minimum lethal doses for 3,300 c.c. and 4,000 c.c. of empty space respectively;

(*iv*) that mercury vapour penetrates the eggs through the micropyle;

(*v*) that, in a known empty and enclosed volume of space in which eggs and mercury are kept simultaneously, mercury kills the eggs of *Corcyra cephalonica* and *Bruchus chinensis* 48 hours after exposure;

(*vi*) that the minimum lethal dose of mercury effective in a particular volume of empty space is not necessarily wholly effective on all the eggs in the same volume of grain-filled space.

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A CHLOROSIS OF PADDY (*ORYZA SATIVA* L.) DUE TO SULPHATE DEFICIENCY

By S. P. Aiyar

(*Agricultural Chemist, Burma, Delhi*)

SINCE 1926 the author has been engaged in studies on the nutritional disorders of the paddy plant and on their correction by manurial treatment. A large volume of work has been carried out but publication was held up in the hope of completing the studies and presenting the work in comprehensive form. Owing to unexpected developments, however, further work on the subject is likely to be indefinitely delayed so that the publication of important facts appears to be desirable. This note deals with the effects of sulphate deficiency.

A chlorosis of paddy, fairly widespread on the Mandalay Agricultural College Farm, was attributed by the author to a possible deficiency of sulphur on the basis of the following observations:—

(1) Experiments on the manuring of paddy on the Farm soil with cyanamide, urea and ammonium bicarbonate during 1926-29 showed that the treated plants were generally chlorotic whereas treatment with ammonium sulphate gave healthy green plants. (2) In the Permanent Manurial Experiment on the Farm, treatment of paddy with sodium nitrate gave chlorotic plants while ammonium sulphate gave normal green plants. (3) There was no trace of chlorosis in the Farm area under the control of the Economic Botanist, Burma, apparently owing to the regular application of Nicifos II on this land, whereas elsewhere on the Farm chlorotic patches were numerous and extensive.

The plants affected by the disorder had the following characteristics:—(1) A general chlorosis with leaves of yellowish green colour, the older leaves being somewhat more greenish than the younger leaves. (2) There was no tendency for the premature death of the older leaves as is usual in cases of nitrogen deficiency. (3) The affected plants were relatively stunted and had fewer tillers and a smaller leaf area than the healthy plants. (4) The chlorotic plants gradually recovered their green colour and remained green and immature at the usual harvest time when the healthy plants had become golden yellow in colour indicating full maturity. (5) Grain formation was not suppressed but the yield of both straw and grain was greatly reduced. (6) The ratio of straw to grain was much narrower in the chlorotic plants than in the healthy plants.

The first experiment to test the effect of sulphate on the chlorotic plants was carried out by the author[1] during the season 1931-32 with the collaboration of the Professor of Agriculture, who provided the necessary facilities. The treatments included magnesium oxide, magnesium chloride and magnesium sulphate with and without ammonium phosphate (free from sulphate). In all cases where sulphate was present the chlorotic plants recovered their normal green colour, made rapid growth and were ripe and ready for harvest along with the healthy plants. On the other hand the plants remained stunted and characteristically immature in all the other treatments. It was thus evident that the chlorosis was not due to a deficiency of nitrogen, phosphate or magnesium. The author's finding that sulphate is the curative agent for the chlorosis was subsequently confirmed by the Mycologist[2] and the Agricultural Chemist,[3] Burma, but neither of them attributed the trouble to sulphur deficiency. The latter[3] also expressed a warning against expecting a beneficial effect from applications of sulphur under normal conditions of growth.

As sources of sulphate for the plant the author found that gypsum, powdered sulphur, iron pyrites and the usual sulphate-containing fertilisers were equally effective, and that a rate of application of ten pounds of sulphur per acre in any of these forms was sufficient to cure the trouble and produce the maximum yield in this soil. The treatments produced their effect within three days after application. Under Burma conditions, iron pyrites appeared to be the most suitable source of sulphate as the mineral is found extensively in the country.

Since many areas on the College Farm were found to respond to ammonium sulphate and to superphosphate, comparative tests were carried out in areas of sulphate deficiency to discover whether the action of these fertilizers was due to their characteristic constituents or due to their sulphate content. It was found that treatment with nitrogenous and phosphatic fertilizers gave large increases in yield when they contained sulphate but not when they contained only chloride or nitrate in place of the sulphate. For instance, ammonium sulphate was far superior to ammonium chloride, urea mixed with calcium sulphate to urea alone, superphosphate to pure monocalcium phosphate, and Nicifos II superior to pure ammonium sulphate. The significance of sulphate in the manuring of paddy has been pointed out by the author[4,5] elsewhere.

The composition of the crop showed the following characteristics:—(1) In the chlorotic plants the straw as well as the grain contained abnormally high percentages of nitrogen compared to the healthy plants, and the yield of crop was found to vary inversely with the nitrogen content (Sen,[6] however, did not find any difference in nitrogen content between the untreated yellow plants and the plants treated with gypsum). The nitrogen test was found to be so sensitive that it could be used to detect the existence of abnormality in the

TABLE I

Yield and Composition of Sulphate-Deficient Paddy after Various Treatments

Season	Treatments	Appearance of crop after treatment	Yield per plot of 180 sq. ft.		Composition of crops at maturity (on dry matter)			
			Straw lb.	Grain lb	Straw N%	Straw S%	Grain N%	Grain S%
A	Untreated-affected ..	Chlorotic	6·5	5·3	0·85	0·062	1·22	0·094
	Untreated-healthy ..	Green	11·5	9·7	0·40	0·122	0·98	0·138
	$MgCl_2$	Chlorotic	5·8	4·9	0·88	0·064	1·28	0·088
	$MgSO_4$	Green	12·3	9·0	0·38	0·133	0·99	0·128
B	Untreated-affected ..	Chlorotic	6·0	4·6	0·82	0·057	1·32	0·084
	Untreated-healthy .	Green	11·4	9·8	0·39	0·118	1·00	0·119
	Gypsum ($CaSO_4$)	,,	12·6	10·2	0·38	0·138	0·95	0·135
	Iron pyrites	,,	13·1	11·3	0·39	0·129	0·98	0·129
	Sulphur	,,	13·5	11·6	0·37	0·127	0·97	0·125
	NH_4Cl	Chlorotic	6·8	5·2	0·85	0·061	1·21	0·081
	$(NH_4)_2SO_4$	Green	11·2	9·5	0·42	0·133	0·97	0·124
	Urea	Chlorotic	7·5	6·2	0·77	0·0 9	1·28	0· 88
	Urea + $CaSO_4$	Green	12·4	10·2	0·41	0·118	0·96	0·119
	$Ca(H_2PO_4)_2$	Chlorotic	6·2	5·8	0·78	0·049	1·26	0·080
	Superphosphate	Green	12·0	9·9	0·40	0·124	1·01	0·115

plant. The test is, however, not specific because nitrogen accumulation has been found to occur also in certain other deficiencies studied by the author.[7] (2) The chlorotic plants contained much less total sulphur than the healthy plants. Microtests with benzidine hydrochloride showed the complete absence of sulphate in the chlorotic plants whereas the healthy plants always showed the presence of sulphate. (3) There was no difference between the chlorotic and the healthy plants in regard to their calcium, magnesium or phosphate contents. (4) The manganese contents of the healthy plants and the sulphate-treated plants were distinctly higher than those of the chlorotic plants. (5) The chlorotic plants contained higher percentages of soluble nitrogen and lower percentages of soluble sugars than the healthy plants.

Selected data are presented in the accompanying table to illustrate the salient features of the work. Only the percentages of nitrogen and sulphur are given as these represent the most important information. Full details will be published shortly.

From the experimental work summarized above it will be seen: (1) that the chlorotic plants contained much less sulphur than the healthy plants; (2) that these chlorotic plants responded to sulphate treatment which led to maximum yields and caused a large increase in sulphur content in the plant; and (3) that sulphate treatment corrected all the abnormalities in the chlorotic plants. It may, therefore, be concluded that the symptoms shown by the chlorotic plants are due to a deficiency of sulphate and that added sulphate acted as a direct nutrient to the plant.

It is necessary to point out that from the data in hand no conclusion can be drawn in regard to the minimum percentage of sulphur in the plant or in the soil which will prevent the chlorosis.

1. "Annual Report of the Professor of Agriculture, Agricultural College, Mandalay, for 1931-32.' 2. 'Annual Report of the Mycologist, Burma, for 1932–33" page 3. 3. "Report on the Operations of the Department of Agriculture, Burma, for 1933–34" page 14. 4 Aiyar, S. P. *Proc. Nat. Inst. Sciences, India*, 19.7, 3, Part 2, 267. 5. —, *Science and Culture*, 19 4, 10 14 –51 6. "Report on the Operations of the Department of Agriculture, Burma, for 193 –38" p. 36. 7 "Annual Report of the Agricultural Chemist, Burma, for 1940–41."

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NEW YEAR'S HONOURS

HIS MAJESTY THE KING has been pleased to confer the distinction of Knighthood on Dewan Bahadur A. Lakshmanaswami Mudaliar, Vice-Chancellor, University of Madras, Dr. C. W. B. Normand, Department of Meteorology, Mr. C. C. Inglis, Director, Indian Waterways Experiment Station, Poona, Mr. B. J. Wadia, Vice-Chancellor, Bombay University, and Mr. J. J. Gandhi, of the Tata Iron and Steel Company. Mr. F. C. Minett, Director, Imperial Veterinary Research Institute, Izatnagar, becomes a C.I.E. These distinguished personages are all familiar to readers of *Current Science*. Our heartiest felicitations to them!

ZOOGEOGRAPHICAL DIVISIONS OF THE WESTERN GHATS, AS EVIDENCED BY THE DISTRIBUTION OF HILL-STREAM FISHES

By B. S. Bhimachar

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Introduction

The importance of treating the Western Ghats hill ranges along with the narrow strip of the West Coast as a distinct zoogeographical subdivision of Peninsular India has been recognised by several workers. Blanford in his classical work on the distribution of vertebrates of India designates this area as the Malabar Tract. Based on the distribution of freshwater sponges and polyzoa, Annandale found it necessary to divide Peninsular India into two subdivisions, (*a*) main area consisting of the Peninsula east of Western Ghats, (*b*) Malabar zone including Western Ghats and the West Coast. Prashad,[30] taking into consideration the results of systematic work on various groups of animals, suggested Peninsular India and Ceylon as one of the five divisions of India, with the Malabar zone as a distinct subdivision. A critical study of the literature on the fish fauna of Peninsular India not only indicates the necessity to regard the Western Ghats together with the hill ranges of Ceylon as distinct from the rest of Peninsular India and Ceylon but also points out the need for further dividing Western Ghats into distinct zoogeographical divisions. The facts of distribution which favour such a division and the probable causes that are responsible for the isolation of fishes on the Ghats are recorded in this paper.

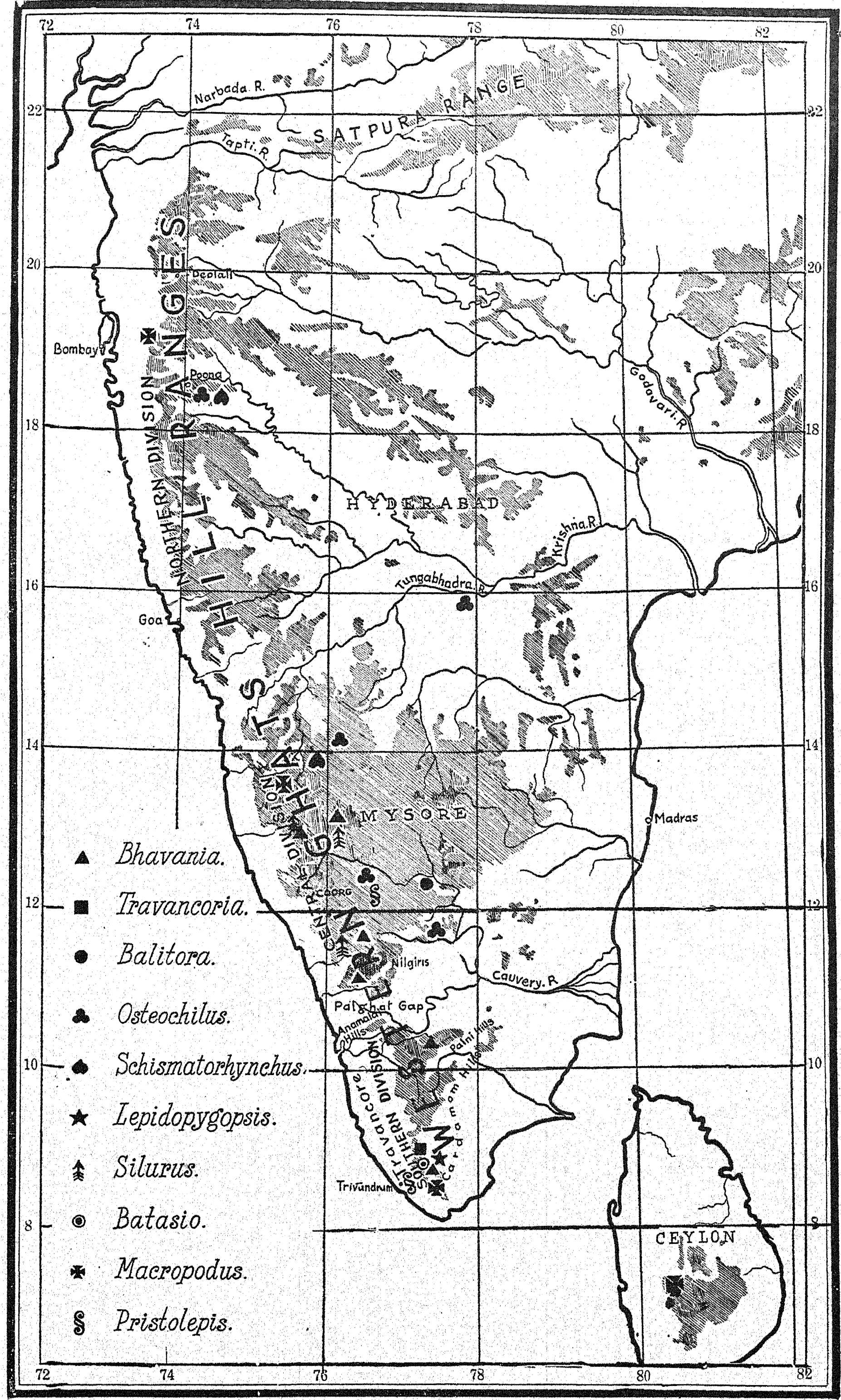
Origin and Evolution of Western Ghats Fish-Fauna

A brief review of the origin, affinities and the evolution of the fish-fauna of the Western Ghats is an essential prerequisite for an attempt to divide the Western Ghats into zoogeographical divisions based on the distribution of fishes. We owe much of our knowledge of the fishes of the Western Ghats to the outstanding researches of Hora on their systematics, affinities and distribution. The two noteworthy features of fishes of the Western Ghats are (*i*) their close affinity to the fishes of Malay Peninsula and Archipelago and (*ii*) richness of the endemic forms. Important among the fishes of Eastern affinity on the Ghats are *Balitora, Travancoria, Bhavania, Schismatorhynchus, Thynnichthys, Osteochilus, Silurus, Batasio, Pristolepis* and *Marcopodus*. The close similarity of the fish-fauna of Peninsular India with that of the Malaya region is explained by Hora[18] on the hypothesis that both are derived from a primitive stock of fishes which originated in Southern China. According to Hora freshwater fishes migrated in batches from the original stock in different directions from the place of their origin about the Miocene Period. One such batch migrated southwards along the Indo-Malayan mountains to the region of Malaya Archipelago and another westwards to the region of Eastern Himalayas and from there to Peninsular India. "It seems probable from the records of distribution of certain specialised hill stream fishes that the Satpura trend of elevated country, which during the Miocene and later periods stretched diagonally across India to the Himalayas, permitted the dispersal of the hill stream forms, by a series of river captures or through deflection, from the Eastern Himalayas to the western limit of the Satpuras and the Vindhyas, whence subsequent to the elevation of the Western Ghats, the fauna migrated along the ghats southwards to the hills of the Peninsula" (Hora).[18] Reports on collections of fishes from isolated hill ranges such as Rajmahal hills in Behar, Sihawa range and Bailadila range in C.P. by Hora,[16,17,19] from Hazaribagh district by Das[2] clearly indicate close affinity between fishes of these hill ranges and those on the Western Ghats on the one hand and those in Assam on the other; which supports the view that these hill ranges should have been continuous, forming highway for migration of fishes from east to west during the Miocene period. The richness of the endemic forms is to be attributed to the long isolation of the fish-fauna on the hill ranges of the ghats and the consequent evolution of large number of new forms.

Zoogeographical Divisions of Western Ghats

At the period of the first influx of fishes from the East on to the Western Ghats, it is assumed, that the whole of the Western Ghats, from the Tapti river to the hills of Ceylon, was a continuous range, which permitted the dispersal of fishes throughout the Ghats through a system of river captures due to a differential rise of the Western Ghats. Subsequent to this period there have been geological changes by which parts of this once continuous hill range became isolated into hill groups thus restricting the movements of fishes. Such geological changes are (1) separation of Ceylon from the Peninsula, (2) denudation of the ghats by the upper reaches of the rivers of the Peninsula resulting in the formation of deep river valleys and (3) Deccan Trap eruptions.

Ceylon.—A list of freshwater fishes of Ceylon prepared from the series of articles by Deraniyagala[3–6] shows the basic continuity of the fish-fauna of Ceylon and Peninsular India. As many of the South Indian genera and species of fishes are represented in the fauna of Ceylon, it is clear that Ceylon became separated from India after the migration of these fishes to the island. In Ceylon there are a number of endemic forms such as *Horadandia atukorali* Deraniyagala, a small-sized cyprinoid, an anabantoid *Malpulutta kretseri* Deraniyagala and a few species of *Garra, Rasbora, Barbus, Labeo* and *Clarias* which have evolved as a result of long isolation of the island from the mainland. This is further evidenced by the recent discovery by Deraniyagala of Siwalik mammals in Ceylon which although generically identical with those of India, have been isolated sufficiently long to form separate species,



Map of Peninsular India showing the distribution of certain hill-stream fishes.

Based on the distribution of fishes, three zoogeographical divisions of the Western Ghats can be recognised. For purposes of description they can be termed Northern, Central and Southern Divisions. The Northern Division consists of the Deccan Trap area from the Tapti river up to 16° n. latitude about the level of Goa. The Central Division extends from 16° n. latitude southwards and includes the Malnad parts of Mysore State, Coorg, Wynaad, parts of South Canara district and Nilgiris The Southern Division comprises Anamalai, Palani and Cardamom hills of Travancore.

Northern Division.—The classical work of Sykes on the fishes of Deccan (1841) is in main the basis of our knowledge of the fishes of this division. Fraser[7,8] and Hora and Misra[15,26] have recently described extensive collections of fishes from the environs of Deolali and Poona. Hora and Misra have recorded 50 species from Deolali and 53 species from Poona and a list prepared from these two areas together contains about 70 species. The occurrence of *Schistmatorhynchus* Bleeker and *Mystacoleucus* Gunther is of special significance; besides the Western Ghats, the former is found in the Malaya Archipelago, while the latter is found in Burma, Siam, Malaya, etc., but nowhere else in India. These two genera show the Malayan affinities of the fauna of this part of the Western Ghats (Hora).[26] Suter has reported 17 species from Poona in addition to the number described by Hora and Misra from that area and his record of *Osteochilus nashii* (Day) and *Garra bicorunta* Rao is of zoogeographical interest as it extends the distribution of these species to the Northern Division. Rahimulla and Das[31-33] have reported on the fishes of Hyderabad and the list of fishes of Hyderabad prepared by Rahimulla (manuscript) contains 93 species. The occurrence here of *Thynnichthys* and *Osteochilus* is noteworthy as they represent the eastern element in the fauna of Hyderabad. The majority of fishes in this division have a wide distribution. Further, compared with the Central and Southern Divisions the fish-fauna of Northern Division is noticed to be markedly poor. Except for *Parasilorhynchus prateri* Hora, *Horaichthys setnai* Kulkarni, a species each of *Rasbora, Danio* and *Barbus* and a few others the endemic forms are also few here. Forms of zoogeographical interest such as *Balitora, Bhavania, Travancoria, Pristolepis, Silurus, Batasio* and others which occur lower down on the ghats are absent in this division.

Central Division.—The fish-fauna of the Central Division is comparatively better known. In recent years Rao,[34] Hora[10,12,25] Mukerjee[21] and Bhimachar and Rau[1] have contributed to our knowledge of the fishes of this division. The list of fishes from Mysore and adjoining hill ranges of Nilgiris, Wynaad and Coorg, published by Hora,[25] contains 121 species. From the records of fishes from different parts of Western Ghats it may be estimated that the Central Division presents the richest fish-fauna. There are here certain forms of immense zoogeographical significance. The *Silurus* reported from this division is the same species that is found from Cochin China to Eastern Himalayas. *Balitora brucei* var. *mysorensis* Hora, a variety of the Burman form occurs in Mysore. Hora has pointed out that the three species of *Scaphiodon* found in this division are referable to *Osteochilus*, a genus widely distributed in South Eastern Asia and that *Labeo nukta* Sykes, actually belongs to the Malayan genus *Schismatorhynchus* which was hitherto known only from Sumatra and Borneo. All these except *Schismatorhynchus* and a species of *Osteochilus* which are reported from the Northern Division, are restricted to the Central Division. It is significant that these are absent in the Southern Division. The South Indian Homalopterid genus *Bhavania* occurs both in the Central and Southern Divisions. While classifying the fishes of this division in respect of the different drainages it was noticed that several of Sykes' Deccan species are found in the headwaters of the Tungabhadra river and these are strikingly absent south of this drainage.

Southern Division.—John[27] and Hora and Law[22] have reported on large collections of fishes from Travancore. The northern part of this division, namely, Anamalai hill ranges is still a virgin field. Hora and Law[22] in their article "Freshwater Fish of Travancore", list 76 species. To this list has to be added the new species of Globe fish—*Tetradon* (*Monotretus*) *travancoricus* and the gobioid—*Sicyopterus griseus* (Day) recently reported by Hora and Nair[23] and also Sundara Raj's[35,36] new find *Lepidopygopsis typus* and a species of *Barbus*. It is possible that *Lepidopygopsis* has affinity with the Schizothoracine fishes found in Yunnan. The discovery of a new Homalopterid—*Travancoria jonesi* and a Siluroid—*Batasio travancoria* by Hora,[21,20] deserves special mention as they show close relationship with Eastern fishes. All these except *Sicyopterus* are endemic in this division.

In addition to the above dissimilarity among the fishes of the Central and Southern Divisions, it may further be pointed out that there is abundant endemicity among the fish-fauna of the two areas. Out of 121 species from the Central Division 24 are restricted to that area. If the range of distribution is extended to Deccan also about 33 species are endemic which are absent from the Southern Division. Thirteen out of 81 species in Travancore are endemic there. Hora and Law[22] state "The high endemicity of the Travancore fauna is an evidence of its antiquity and long isolation from the fauna of the mainland of India and adjacent countries. After migration from north-east to south-west, the fauna came to a blind end in the Peninsular region and when, with the formation of the Rajmahal-Garo hill gap and due to other causes, it became isolated and it had sufficient time to blossom out into distinct species while still retaining its family affinities with the parent stock." It may be stated that this remark holds good equally to the fauna of the whole of the Western Ghats. The fauna of Travancore, in particular, has further been isolated from the neighbouring hill ranges of Nilgiris and Mysore.

Discussion

From the foregoing observations it is clear that (1) there is dissimilarity among the fish-fauna of the three divisions of the Western Ghats, (2) the Central and Southern Divisions not merely have large number of fishes of far-eastern affinity but also possess rich endemic forms. An attempt will now be made to account for such geographical differentiation among the fishes of Western Ghats.

It is argued that the geographical differentiation or the dissimilarity between the fishes of the Central and Southern Divisions is due to the presence of a low stretch of land in east to west direction about 16 miles wide and hardly about a thousand feet in elevation known as the Palghat Gap between Nilgiris and Anamalai hills, acting as a barrier for the intermingling of fishes of the two areas, just as the Rajmahal-Garo hill gap which is a barrier between Eastern Himalayan region and Peninsular India. It is well known that a low land like the Palghat gap forms an effective barrier for the intermingling of fishes of the neighbouring hill ranges. With the formation of the Palghat gap the fauna of the Central and Southern Divisions became isolated. In his article on the Dragonflies of Western India, Fraser[9] has referred to the Palghat gap as being an important barrier affecting their distribution. He states, "A study of the fauna on the two sides of the gap has served to show that narrow as it is, it is sufficient to divide the fauna into northern and southern groups". From the distribution of the fishes of Peninsular India it is clear that the Palghat gap must have occurred after the migration of fishes to the extreme south of India on to the Travancore hills. Hence the view expressed by Medlicott and Blanford[28] that "It is also possible that the isolation of the different hill ranges of South India, such as the Shivarai, and the denudation of the Palghat gap south of the Nilgiris, are due in part to ancient marine action of the date as the formation of the Shyadri escarpment" cannot be regarded as correct. It is possible that it is a valley of a former river. It may be stated that whatever may have been the cause of the formation of this gap; it must have been an elevated country at the time of the migration of fishes southwards with the drainage facilitating such a migration.

In respect of geological formations the Northern Division is one which was subjected to violent volcanic eruptions resulting in the formation of Deccan Traps and is formed of basaltic rocks while the Central and Southern Divisions are formed of archæan rocks and are comparatively undisturbed parts except for erosion by the upper reaches of rivers. The poor fish-fauna of the Northern Division is probably due to the fact that considerable amount of their existing fauna must have been destroyed by the volcanic eruptions and that is why Homalopteridæ, *Silurus*, *Batasio*, etc., are not found there. The Central and Southern Divisions, being comparatively stable land masses, appear to have presented a favourable habitat for these fishes to thrive. Further isolation of the hill ranges in these divisions may have been responsible for the evolution of a large number of new forms giving high endemicity to these areas. The rapid speciation in the streams on the hill slopes covered with thick tropical forests in these divisions from Miocene period onwards is not a matter of great surprise as they are subjected to heavy monsoons resulting in varied types of seasonal habitats.

The distribution pattern of fishes on the Western Ghats lends support to the view that the freshwater fishes from the east came to the Western Ghats by a series of successive waves of migration. Roughly four such waves of migration can be recognised. The first batch of fishes migrated to the ghats at a time when the conditions were more or less stable and specialised forms like the Homalopteridæ had not yet evolved. Ceylon, which was not detached from the peninsula at this period, received part of this generalised fauna. The second wave of migration from the east came after the separation of Ceylon from India but before the formation of the Palghat gap and must have been preceded by violent orogenic changes for such specialised hill stream forms as the Schizothoracinæ and the Homalopteridæ had already come into existence by then. This wave of migration spread to the extreme south of the peninsula and we have evidence of it in the present-day fauna. The third wave of migration from the east came after the formation of the Palghat gap and gave a rich fauna to Mysore and the adjoining hill ranges. Forms like *Silurus*, *Schismatorhynchus*, *Osteochilus*, *Balitora* and others must have come with this batch and the Palghat gap appears to have prevented their further migration southwards. It is assumed that about this period the Deccan plateau was about to have volcanic eruptions, the occurrence of which resulted in the elimination of much of the then existing fauna in the Northern Division. The fourth wave probably came after the Deccan Traps had been laid bringing with it forms like *Schismatorhynchus*, *Mystacoleucus*, *Thynnichthys* and *Osteochilus* to the Northern Division.

I am much indebted to Rai Bahadur Dr. S. L. Hora, Director of Fisheries, Bengal, for reading through the manuscript and making valuable suggestions and to Prof. L. Rama Rao, Bangalore, for affording me an opportunity to discuss with him on the Geology of South India.

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MAGNETISM IN RELATION TO STRUCTURE*

AFTER a brief introduction by Prof. Krishnan, the discussion was opened by Sir C. V. Raman, F.R.S., N.L., with the subject "Magnetic Susceptibility of Minerals". He outlined the work that had been carried out in his laboratory for some time. Starting with a tektite from the island of Billiton which proved to be an isotropic glass-like material, successively other minerals have been studied for their magnetic behaviour. An examination of a number of tourmalines showed considerable variations in both susceptibility and anisotropy and the interesting result that there was a close correlation between the two was obtained. Results of even greater theoretical and practical interest were obtained with the minerals iron pyrites and augite.

The iron pyrites used in the investigations were obtained from Nepal in the form of cubes with well-developed faces and of a tin-white colour, instead of the more common golden yellow. The crystals exhibited a brilliant metallic lustre. The susceptibility of the large number of specimens investigated varied from $0{\cdot}2 \times 10^{-6}$ to 190×10^{-6}, the greater part, however, being near the lower value. All the specimens showed a decrease in susceptibility with increase in field strength, the dependance on the field strength being larger, the larger the susceptibility of the specimen. Temperature had apparently no influence nor was there any sign of remanant magnetism.

The behaviour of augite also showed interesting points, the mineral being axially ferromagnetic, anisotropic at low fields and isotropic at high field strengths. While no generalisations could be attempted at this stage, the observations may be considered to open up a fresh field and, as in other cases the magnetic investigation of naturally occurring minerals may throw light where studies with pure substances have failed!

Dr. Mata Prasad, of the Royal Institute of Science, Bombay, next presented a brief resumé of the work carried out by him in collaboration with Dr. S. S. Dharmatti and other students, on "Ionic Susceptibilities and Molecular Configuration". After dealing with the historical background, both in theory and in experiment, which showed clearly the anomalous state of affairs in the correlation of theory with experiment, Dr. Prasad dealt at some length with his work on the sulphur group and in the alkaline earth group. The use of susceptibility data in the assignment of structures was illustrated by taking as examples sulphur monochloride (disulphur dichloride), the selenium analogue and chromium dioxide. It may be mentioned in passing that these results are not quite in accord with structures indicated by the study of other properties, a point to which attention was drawn in the course of the discussion.

An interesting observation pointed out by Dr. Prasad in dealing with the alkaline earth group was the apparent variation in the cationic susceptibility with the nature of the anion when salts of organic acids were studied. There appeared to be a correlation between "the total number of electrons" or the "number of carbon atoms in the molecule" and the increase in cationic susceptibility. Here again, one cannot overlook the possibility that the real abnormality is with the organic ion.

Dr. S. V. Anantakrishnan, of Madras Christian College, Tambaram, followed next with "Diamagnetism and Chemical Bonding". While Pascal's additivity relationship has served a useful purpose in correlating diamagnetic susceptibility with the structure of carbon compounds, as in case of other physical properties, a different method of interpretation is possible correlating susceptibility with molecular structure in the light of present knowledge on the nature of valency. Following the method of Gray and Cruikshank, but using Slater's method for the evaluation of ionic susceptibilities, the paramagnetic contribution through bond formation can be evaluated as 'bond-depressions'. Using these values and the known values of bond moments, diamagnetic susceptibilities of a large number of compounds on calculation gave consistently close agreement with the experimentally determined values. It was also noticed an empirical curve could be drawn correlating bond-order with bond-depressions and, using this curve, the calculated and observed values in the case of resonance structures showed good correlation. By the same procedure the susceptibilities of the ammonium and the nitrate ions could be evaluated and the sum of these gave the molecular susceptibility of ammonium nitrate within the limits of experimental error. It may be remarked that the accuracy of susceptibility determinations preclude any use of this as a means of determining structure, but there is no reason to consider that these data should be interpreted without reference to existing knowledge as to structure and valency.

In the brief discussion that followed, Dr. C. Mahadevan, Dr. Dharmatti, Principal S. Bhagavantam, Prof. T. R. Seshadri, the Chairman and others took part.

S. V. A.

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* Report of a discussion at the Joint Annual Meeting of the Indian Academy of Sciences and the National Academy of Sciences, held at Poona, on 28th December 1944, with Professor K. S. Krishnan, F.R.S., in the Chair.

LETTERS TO THE EDITOR

ELASTIC CONSTANTS OF QUARTZ

The elastic constants of quartz have been determined by Voigt[1] by static methods, and by Atanasoff and Hart[2] by dynamical methods employing high frequencies. Variously oriented quartz plates were used by these authors. In the present investigation, the phenomenon of the diffraction of light by ultrasonic waves set up in liquids has been utilised for detecting the resonant frequencies of the piezoelectrically-driven plates of quartz.

Quartz (point group D_3) has six elastic constants. The velocities of propagation of a sound wave in a direction normal to the face of an X-cut plate are the roots of

$$(C_{11}-\rho c^2)[(C_{66}-\rho c^2)(C_{44}-\rho c^2)-C^2_{14}]=0 \quad .. \quad (1)$$

The linear mode corresponds to a longitudinal vibration which gives intense diffraction patterns if the plates are silvered uniformly and these are used for evaluating C_{11}. The quadratic form represents two more complicated modes one of which can be made to appear when the plates are unsymmetrically silvered. Similarly the velocities in a direction normal to a Y-cut plate are the roots of

$$(C_{66}-\rho c^2)[(C_{11}-\rho c^2)(C_{44}-\rho c^2)-C^2_{14}]=0 \quad .. \quad (2)$$

The linear factor comes out as an independent torsion even when fully silvered plates are used and yields C_{66}. From the relation $C_{66} = (C_{11} - C_{12})/2$, C_{12} may be calculated. The coupled modes corresponding to the quadratic factor in (2) are excited by adopting unsymmetrical silvering. Solving the quadratic factors of (1) and (2), the constants C_{44} and C_{14} are evaluated. For a plate cut with its normal in the YZ plane and making an angle of 135° with the Z axis, the velocities of propagation will be the roots of

$$[\tfrac{1}{2}(C_{44}+C_{66}-2C_{14})-\rho c^2]\{[\tfrac{1}{2}(C_{11}+C_{44}+2C_{14})-\rho c^2] \times [\tfrac{1}{2}(C_{33}+C_{44})-\rho c^2]-\tfrac{1}{4}(C_{13}+C_{44}+C_{14})^2\}=0 \quad .. \quad (3)$$

The quadratic factor contains two modes excited by unsymmetrical silvering and one of them is used for evaluating C_{13}. In evaluating the constant C_{33}, a Z-cut plate is taken and the method of transmission evolved in this laboratory and described in a previous paper[3] is employed. A consideration of the modes left out in the above calculations furnishes two or three additional checks. The results thus obtained have been corrected for the forces arising from the polarization produced by the vibrations as pointed out by Lawson[4] and the corrected values along with those of Voigt (static) and Atanasoff (dynamic) are given below:—

Elastic Constants of Quartz

	Author	Voigt	Atanasoff
C_{11}	86·94	86·82	86·75
C_{12}	6·96	7·09	6 87
C_{44}	57·62	58·23	57·86
C_{13}	15·60	14·38	11·[illegible]0
C_{33}	10[illegible]·80	107·45	1[illegible]6·80
C_{14}	17·43	17·15	17·96

Agreement is satisfactory in respect of all the constants except C_{13}. In this case Atanasoff used an orientation which results in a very complicated expression and a large correction. The discrepancy is probably due to this.

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December 11, 1944.

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THE DISTRIBUTION OF THE MEAN OF SAMPLES FROM A RECTANGULAR POPULATION

IRWIN[1] has obtained the distribution of the mean of samples from a rectangular population by using characteristic functions. It has been shown in this note that this distribution can be obtained by using either of the two sets of multiple integrals given below :—

$$\frac{d}{d\bar{x}}\int_0^{n\bar{x}}\int_0^{n\bar{x}-x_1}\cdots\int_0^{n\bar{x}-x_1-x_2\cdots x_{n-1}} dx_1\,dx_2\cdots dx_n = \frac{n^n}{\Gamma_n}\,\bar{x}^{n-1} \qquad (1)$$

$$\frac{d}{d\bar{x}}\int_1^{n\bar{x}}\int_0^{n\bar{x}_1-x_1}\cdots\int_0^{n\bar{x}-x_1-x_2\ldots x_{n-1}} dx_1\,dx_2\cdots dx_n = \frac{n^n}{\Gamma_n}\left(\bar{x}-\frac{1}{n}\right)^{n-1} \qquad (2)$$

$$\frac{d}{d\bar{x}}\int_1^{n\bar{x}}\int_1^{n\bar{x}-x_1}\cdots\int_0^{n\bar{x}-x_1-x_2\cdots x_{n-1}} dx_1\,dx_2\cdots dx_n = \frac{n^n}{\Gamma_n}\left(\bar{x}-\frac{2}{n}\right)^{n-1} \qquad (3)$$

....

.... (A)

Same as (1) of (A) (1)

$$\frac{d}{d\bar{x}}\int_0^{1}\int_0^{n\bar{x}-x_1}\cdots\int_0^{n\bar{x}-x_1-x_2\cdots x_{n-1}} dx_1\,dx_2\cdots dx_n = \frac{n^n}{\Gamma_n}\left[\bar{x}^{n-1}-\left(\bar{x}-\frac{1}{n}\right)^{n-1}\right] \qquad (2)$$

$$\frac{d}{d\bar{x}}\int_0^{1}\int_0^{1}\cdots\int_0^{n\bar{x}-x_1-x_2\cdots x_{n-1}} dx_1\,dx_2\cdots dx_n = \frac{n^n}{\Gamma_n}\left[\bar{x}^{n-1}-2\,c_1\left(\bar{x}-\frac{1}{n}\right)^{n-1}+\left(\bar{x}-\frac{2}{n}\right)^{n-1}\right] \qquad (3)$$

$$\frac{d}{d\bar{x}}\int_0^{1}\int_0^{1}\int_0^{1}\cdots\int_0^{n\bar{x}-x_1-x_2\cdots x_{n-1}} dx_1\,dx_2\cdots dx_n = \frac{n^n}{\Gamma_n}\left[\bar{x}^{n-1}-3\,c_1\left(\bar{x}-\frac{1}{n}\right)^{n-1}+3\,c_2\left(\bar{x}-\frac{2}{n}\right)^{n-1}-\left(\bar{x}-\frac{3}{n}\right)^{n-1}\right] \qquad (4)$$

....

$$\frac{d}{d\bar{x}}\int_0^{1}\int_0^{1}\ldots p\text{ times}\ldots\int_0^{n\bar{x}-x_1-x_2\ \ x_{n-1}} dx_1\,dx_2\ldots dx_n = \frac{n^n}{\Gamma_n}\left[\bar{x}^{n-1}-p\,c_1\left(\bar{x}-\frac{1}{n}\right)^{n-1}+p\,c_2\left(\bar{x}-\frac{2}{n}\right)^{n-1}-p\,c_3\left(\bar{x}-{}_n\right)^{n-1}\cdots(-)^p\left(x-\frac{p}{n}\right)^{n-1}\right]\ldots (p+1)$$

(B)

The probability of a sample of size n, with values lying between x_1, x_1+dx_1; x_2, x_2+dx_2; .. ..x_n, x_n+dx_n is

$$dx_1\,dx_2\ldots\ldots dx_n$$

Using (1) of A, the distribution of

$$\bar{x}=\frac{x_1+x_2\cdots x_n}{n} \text{ is}$$

$$\frac{n^n}{\Gamma_n}\,\bar{x}^{n-1}\,dx.$$

But it can be seen that this distribution is valid only so long as $nx \leqslant 1$. When $n\bar{x} > 1$ some of the observed values $x_1, x_2, \ldots x_n$ can be > 1 and they are also included in the distribution obtained. Hence the distribution of the mean for the interval 0 to $\frac{1}{n}$ is

$$\frac{n^n}{\Gamma_n}\,\bar{x}^{n-1}\,d\bar{x} \qquad \text{(C)}$$

When $\bar{x}$ lies between $\frac{1}{n}$ and $\frac{2}{n}$, $n\bar{x}$ lies between 1 and 2 and it is possible that one of the n observed values is > 1 and the distribution of $\bar{x}$ corresponding to these values should be subtracted from (C). It can be seen the distribution of $\bar{x}$ when one of the observations is > 1 is given by (2) of (A). As there are ${}_nC_1$ ways of having one of the observations > 1, the distribution of $\bar{x}$ for the interval $\frac{1}{n}$ to $\frac{2}{n}$ is

$$\frac{n^n}{\Gamma_n}\left[\bar{x}^{n-1}-{}_nC_1\left(\bar{x}-\frac{1}{n}\right)^{n-1}\right]d\bar{x} \qquad \text{(D)}$$

It may be noted that (D) is also equal to ${}_nC_1\cdot(2)-{}_nC_0\cdot{}_{n-1}C_1\cdot(1)$, where (2) and (1) refer to (B).

When $\bar{x}$ lies between $\frac{2}{n}$ and $\frac{2}{n}$, two of the n observed values can be > 1 and the distribution can be got by subtracting the distribution corresponding to this portion from (D). First we note that when two of the observations are > 1, the distribution is given by (3) of (A). Out of the n observations, the number of combinations having two observations > 1 included in (1) and (2) of (A) is ${}_nC_2$ and $n\ (n-1)$ respectively. Adding them with the proper signs we find that $-\frac{n\,(n-1)}{2}$ sets of observations having two values > 1 are to be subtracted from (D) to have the distribution of $\bar{x}$ in the range $\frac{2}{n}$ to $\frac{3}{n}$.

Hence the distribution of $\bar{x}$ in the interval $\frac{2}{n}$ to $\frac{3}{n}$ is

$$\frac{n^n}{\Gamma_n}\left[\bar{x}^{n-1}-{}_nC_1\left(\bar{x}-\frac{1}{n}\right)^{n-1}+{}_nC_2\left(\bar{x}-\frac{2}{n}\right)^{n-1}\right]d\bar{x}. \qquad \text{(E)}$$

It will be seen that (E) is also equal to ${}_nC_2\ (3)\quad {}_nC_1\cdot{}_{n-2}C_1\cdot(2)+{}_nC_0\cdot{}_{n-1}C_2\ (1)$, where (3), (2) and (1) refer to (B).

When $\bar{x}$ lies between $\frac{3}{n}$ and $\frac{4}{n}$ three of the observed values can be > 1, and the distribution corresponding to these values is to be subtracted from (E) to get the correct distribution for the interval $\frac{3}{n}$ to $\frac{4}{n}$ of $\bar{x}$. As in the previous cases, when three of the observations are > 1, the distribution for such cases is given by (4) of (A). The number of combinations having

three observations > 1 included in (1), (2) and (3) of A is

$${}_nC_3, \frac{n\,(n-1)\,(n-2)}{\lfloor 1 \lfloor 2} \text{ and } \frac{n\,(n-1)\,(n-2)}{\lfloor 2}$$

respectively. Adding them with the proper signs it will be seen that ${}_nC_3$ samples with three observations in each > 1 are to be subtracted from (E) and the final distribution of $\bar{x}$ for the interval $\frac{3}{n}$ to $\frac{4}{n}$ becomes

$$\frac{n^n}{\Gamma_n}\left[\bar{x}^{n-1} - {}_nC_1\left(\bar{x}-\frac{1}{n}\right)^{n-1} + {}_nC_2\left(\bar{x}-\frac{2}{n}\right)^{n-1} - {}_nC_3\left(\bar{x}-\frac{3}{n}\right)^{n-1}\right] d\bar{x} \qquad \text{(F)}$$

As in the previous cases (F) can be shown to be equal to

${}_nC_3\cdot(4) - {}_nC_2\cdot{}_{n-3}C_1\cdot(3) + {}_nC_1\cdot{}_{n-2}C_2\cdot(2) - {}_nC_0\cdot{}_{n-1}C_3\cdot(1)$, where (4), (3), (2) and (1) refer to (B).

The above argument can be extended to the case of $\bar{x}$ lying in the interval $\frac{p}{n}$ and $\frac{p+1}{n}$, p being $< n$. The number of combinations having p observations > 1 to be subtracted from the distribution for the interval $\frac{p-1}{n}$ and $\frac{p}{n}$ is

$${}_nC_p - {}_nC_1\cdot{}_{n-1}C_{p-1} + {}_nC_2\cdot{}_{n-2}C_{p-2}\cdot\ldots\ldots + (-)^{p-1}{}_nC_{p-1}\cdot(n-p).$$

This is equal to + or − ${}_nC_p$ according as p is odd or even. Hence the distribution for the interval $\frac{p}{n}$ and $\frac{p+1}{n}$ is obtained by subtracting $(-)^{p-1}\,{}_nC_p$ times the distribution of samples having p observations > 1 from the distribution for the preceding interval.

In general the distribution of $\bar{x}$ for the interval $\frac{p}{n}$ to $\frac{p+1}{n}$ is also given by

$${}_nC_p\cdot(p+1) - {}_nC_{p-1}\cdot{}_{n-p}C_1\cdot(p) + {}_nC_{p-2}\cdot{}_{n-p+1}C_2\cdot(p-1)\ldots\ldots + (-)^p\,{}_nC_0\cdot{}_{n-1}C_p\cdot(1),$$

where $(p+1)$, (p),.... (1) refer to the integrals given in (B).

The above method of approach will lead to the distribution of the means of Type II and I curves which will be useful in getting the distribution of the mean of $Y=\left(1+\frac{T^2}{N-1}\right)$, where T^2 refers to Hotelling's[2] T^2. As the actual expressions for the distribution of $\bar{Y}$ are complicated they will be dealt with in another communication.

P. V. Krishna Iyer.

Imperial Agricultural
Research Institute,
New Delhi, *July* 12, 1944.

1. Irwin, J. O., *Biometrika*, 1927, **19**, 225. 2. Hotelling, H., *Annals of Math. Stat.*, 1931, **2**, 360.

NEW BANDS OF THE Hg Br MOLECULE

In the course of a reinvestigation of the band systems of the HgBr molecule, in order to bring them into conformity with those of HgCl, the authors have obtained a new band system in the region λ 2470-λ 2430, consisting of diffuse and headless bands. About thirty bands could be measured and assigned to the three sequences (0,1), (0,0) and (1,0). The intensity distribution gives a narrow Condon Parabola. The following vibrational constants have been determined:—

$$\nu_e = 40720 \quad \begin{matrix} w_e' = 166\cdot0 & w_e'' = 183\cdot0 \\ x_e'\,w_e' = 1\cdot1 & x_e''w_e'' = 2\cdot0 \end{matrix}$$

The final state of this system appears to be the same as the final state of the class I system of the HgBr bands, studied previously by Wieland[1] and by Sastry.[2] Full details will be published shortly.

K. R. Rao.
G. V. S. Ramachandra Rao.

Andhra University,
Guntur,
November 20, 1944.

1. Wieland, *Helv. Acta. Phys.*, 1929, **2**, 46 and 77.
2. Sastry, *Nat. Inst. Sci. Ind., Proc.*, 1941, **7**, 359.

MAGNETISM OF GERMANIUM

From several points of view, germanium is an interesting element. It crystallizes in the diamond structure. But in electrical properties, it behaves like a semiconductor. Unlike diamond, germanium is soft and has a metallic lustre. One would expect these properties to be reflected in the magnetic behaviour of germanium.

This element has been studied by Owen (1912) who obtained $-0\cdot12$* as its specific susceptibility. A redetermination of the susceptibility seemed desirable since a sample of Hilger's spectroscopic brand was available. Curie's method was adopted, using water as the standard. The element showed a trace of ferromagnetic impurity, for which due correction was made. The average specific susceptibility obtained with two pieces was found to be $-0\cdot147$. This gives for the atomic susceptibility the value $-10\cdot7$.

Diamond, silicon, germanium and grey tin belong to the same class of elements from the point of view of crystal chemistry. It is obvious, however, that germanium stands unique on account of some of its properties being absent in the other cases.

A calculation of the atomic susceptibility of germanium on the basis of Slater's method, as modified by Angus (1932) gives $-40\cdot9$. On the same basis, the ionic susceptibility of Ge^{++} (which is in $^1S_0$ state) works to $-16\cdot8$ while the experimental value for the metal is $-10\cdot7$. These results suggest that the metal contains Ge^{++} ions, with the two $4p$ electrons showing evidence of both valence characteristics and metallic bond. That the valence characteristics are predominant and the metallic bond subdued are apparent from the following facts.

Owen (1912) found that when the element is melted, there is a large rise in the diamagnetic susceptibility. In the case of covalent or homopolar combination, the increase of diamagnetism is accompanied by a link depression. On melting, this depression should partly vanish and the valence electrons would evince a larger diamagnetism.

I am indebted to Dr. K. Rangadhama Rao for the specimen of germanium.

Central College,
Bangalore, S. RAMACHANDRA RAO.
January 10, 1945.

* All susceptibility values are given in 10^{-6} unit.

Owen, *Ann. der. Phys.*, 1912, **37**, 657. Angus, *Proc. Roy. Soc.*, 1932, **136**, 569.

A NEW METHOD OF DESIGNING PACKED COLUMNS

PACKED columns have been designed using almost exclusively overall transfer coefficients and overall H.T.Us rather than individual film coefficients and individual H.T.Us. Since the overall transfer coefficients and overall H.T.Us are defined (for distillation) as follows:—

$$\frac{1}{K_G a} = \frac{1}{k_G a} + \frac{m}{k_L a}$$

$$\frac{1}{K_L a} = \frac{1}{k_L a} + \frac{1}{m\, k_G a}$$

$$\text{H.T.U}_{OG} = \text{H.T.U}_G + \text{H.T.U}_L \frac{mG}{L}$$

$$\text{H.T.U}_{OL} = \text{H.T.U}_L + \text{H.T.U}_G \frac{L}{mG}$$

where G = the rate of flow of the vapours in $\frac{\text{lb. moles}}{\text{hr.} \times \text{sq. ft.}}$

L = the rate of flow of the overflow in $\frac{\text{lb. moles}}{\text{hr.} \times \text{sq. ft.}}$

m = the slope of the equilibrium curve.

their use for design purposes can only be justified when they are constant. For example this happens to be so (1) when the resistance of one of the films predominates over that of the other, so that the resistance of the second can be neglected, (2) when the value of "m" remains constant. When both the films are controlling, and the vapour-liquid equilibrium curve is not a straight line, then $K_G a$, $K_L a$, H.T.U_{OG} & H.T.U_{OL} are functions of the slope m; and since m is a variable they cannot be used for design purposes. They are, nevertheless, used (incorrectly) as no alternative method of approach has been presented to the Chemical Engineer.

If the reasonable assumption be made that the slope of the equilibrium curve is constant over small distances:—

$$m = \frac{dy_i}{dx_i} = \frac{dy^*}{dx} = \frac{dy}{dx^*},$$

where y_i and x_i are the interfacial compositions in any differential section of a packed column.

y^* is the composition of the vapour in equilibrium with liquid of composition x present in the differential section.

x^* is the composition of the liquid in equilibrium with vapour of composition y present in the same section

then equations can be derived by means of which the height of any packed column can be computed:—

$$h = \underbrace{\frac{G}{k_G a}\int_{y_F}^{y_D} \frac{dy}{(y^* - y)}}_{\leftarrow N_{G_1} \rightarrow} + \underbrace{\frac{L}{k_L a}\int_{y_F^*}^{y_D^*} \frac{dy^*}{(y^* - y)}}_{\leftarrow N_{G_2} \rightarrow} \quad (1)$$

$$h = \underbrace{\frac{G}{k_G a}\int_{x_F}^{x_D} \frac{dx}{(x - x^*)}}_{\leftarrow N_{L_1} \rightarrow} + \underbrace{\frac{L}{k_L a}\int_{x_F^*}^{x_D^*} \frac{dx^*}{(x - x^*)}}_{\leftarrow N_{L_2} \rightarrow} \quad (2)$$

The integrals N_{G_1}, N_{G_2}, N_{L_1} & N_{L_2} can be evaluated graphically. However, if both $k_G a$ & $k_L a$ are unknown, the height can be expressed either in terms of $k_G a$ or $k_L a$. This is done by solving the above as simultaneous equations.

$$h = \frac{G}{k_G a}\left[\frac{N_{G_1}N_{L_1} - N_{G_2}N_{L_2}}{N_{L_1} - N_{G_2}}\right]$$

$$= \frac{L}{k_L a}\left[\frac{N_{G_1}N_{L_1} - N_{G_2}N_{L_2}}{N_{G_1} - N_{L_2}}\right] \quad (3)$$

Full details of the derivation and applications of the above equations will be published elsewhere.

My thanks are due to Dr. M. A. Govinda Rau, at present Reader in the Alagappa Chettiar College of Technology, University of Madras, for the help that he has given me in this investigation.

Chemical Engineering Section,
Indian Institute of Science,
Bangalore, J. SIMON.
November 29, 1944.

A NEW ANTI-SNAKE-VENOM SERUM

THE anti-snake-venom serum in use in India at present is effective only against the venoms of cobra and Russell's viper. Lamb (1903, 1904, 1905) when he prepared this bivalent serum showed that it did not neutralise the venoms of any snakes other than the two (cobra and Russell's viper) against which it was prepared. The only improvement introduced in recent years has been the concentration of the anti-snake-venom serum (Maitra *et al.*, 1933, and Greval, 1934). Thus we have lacked a remedy against the bite of krait and the saw-scaled viper—two snakes as common as cobra and Russell's viper.

We have been working on the preparation of a polyvalent anti-snake-venom serum which would be effective against the poison of all the four common poisonous snakes of India—cobra, Russell's viper, common krait, and saw-scaled viper. In this we have succeeded and have taken up its manufacture at the Haffkine Institute.

We have also worked out a method for assaying our polyvalent anti-snake-venom serum on the lines of Ipsen's method (1938) sponsored by the League of Nations Permanent Commission on Biological Standardisation. We have assayed four batches of our polyvalent serum and find that 1 ml. of our serum neutralises not less than the following quantities of dried venoms, when the serum along with the venom is injected intravenously into white mice: cobra 0·6 mg.; common krait 0·45 mg.; Russell's viper 0·6 mg.; and saw-scaled viper 0·45 mg.

We are arranging to issue our polyvalent serum in lyophilised form, *i.e.*, preserved by drying from the frozen state. In this form the serum does not require to be stored in a refrigerator. It may be stored in any cool dark place and may even be carried in a haversack

on one's back if an occasion demands it. Even when stored at room temperature, it is expected, it will keep its full potency for ten years or so.

The new polyvalent anti-snake-venom serum thus meets the long-felt need for a serum, effective against all the common poisonous snakes of India, and which can be made available at rural dispensaries and other out-of-the-way places where it is needed and has not so far reached.

Haffkine Institute, A. K. HAZRA.
Bombay, D. C. LAHIRI.
January 11, 1945. S. S. SOKHEY.

Greval, S. D. S., *Ind. Jour. Med. Res.*. 1934, **22**, 365. Ipsen, J., *Bull. Health Org., Leag. Nations*, 1938, **7**, 785. Lamb, G., *Scientific Memoirs by Officers of the Medical and Sanitary Department of the Government of India*, 1903, No. **5**. Idem, *Ibid.*, 1904, No. **10**. Idem. *Ibid.*, 1905, No. **16**. Maitra, G. C., *Ind. Jour. Med. Res.*, 1933, **21**, 2.9.

THERMAL REACTIONS OF IRON PYRITES

THESE studies were carried out with several samples of iron pyrites some of which were collected in the field while others were obtained in the laboratory by separation and concentration from its mineral associates. The purities of the samples employed, *viz.*, the FeS_2 contents ranged from 90 to 99·9 per cent. Complete analyses of the samples were also done and the nature and extent of the impurities ascertained.

Some important features of the thermal reactions of iron pyrites under various conditions are the following:—

(1) Absorption of oxygen with consequent increase in weight (about 10 per cent.) of the sample and conversion of the combined sulphur into water-soluble sulphate. (2) Liberation of elementary sulphur to the extent of about 25 per cent. of the sulphur content of the pyrites. (3) Formation of the normal as well as of a basic ferric sulphate. (4) Evolution of sulphuric anhydride in appreciable amounts.

The studies were all carried out in all-glass apparatus adopting standard methods of analysis.

Full details concerning the mechanism of the various reactions and also of their industrial utilisation will soon be presented.

Dept. of Pure & Applied Chemistry,
Indian Institute of Science,
Bangalore, B. S. OGALE.
January 18, 1945. K. R. KRISHNASWAMI.

INFLUENCE OF CARBOHYDRATE TO NITROGEN RATIO ON THE FORMATION OF DIASTASE BY *ASPERGILLUS ORYZAE*

OUR previous work has shown that the formation of diastase by *Aspergillus oryzæ* is influenced by the character and complexity of the nitrogen employed in the culture medium. Further studies have revealed that the carbohydrate-nitrogen ratio appears to constitute an essential factor in the elaboration of the enzyme. It is generally recognised that starch stimulates the production of the enzyme, but no quantitative data is available in literature. The present study has been undertaken to determine the effect of the addition of varying amounts of starch to a given quantity of nitrogen, on the formation of diastase by *Aspergillus oryzæ*.

The method of culturing the fungus, of making the enzyme extract and of determining the

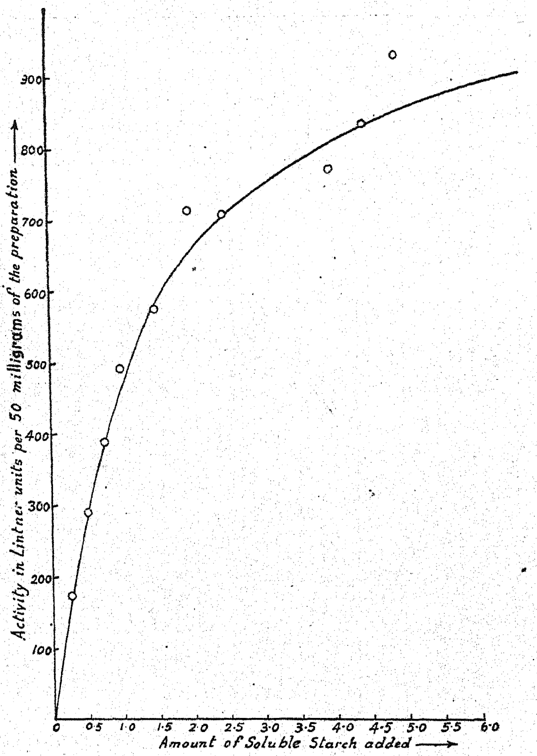

FIG. 1

diastatic activity, are similar to those described in our earlier communications. Finely shredded and acid-digested and purified asbestos was used to provide an inert mat for the growth of the fungus. The basal nutrient solution was composed of:—Peptone (Difco) 60 gms.; potassium dihydrogen phosphate 1 gm.; potassium citrate 1 gm.; magnesium sulphate, $7H_2O$ 1 gm.; ferrous sulphate 0·01 gm.; zinc sulphate 0·01 gm.; calcium chloride 0·5 gm.; water 1 litre.

The medium was constituted as follows:—A given weight (5 gm.) of the asbestos was placed in 250 c.c. conical flasks, moistened with 12·5 c.c. of the nutrient solution (corresponding to 290 mgms. of nitrogen) and treated with graded amounts of soluble starch. The mass was intimately mixed, autoclaved at 20 lbs. for 30 minutes on two successive days. The flasks were then inoculated with a suspension of the spores of the fungus, incubated at 30° C. for three days, the resulting moldy

TABLE I

Reaction Mixture No.	1	2	3	4	5	6	7	8	9	10	11
Starch added in gms.	0,25	0,50	0,75	1.0	1,5	2,0	2,5	3,5	4,0	4,5	5,0
Activity per 50 mgms. of preparation in Lintner units.	173	291	3[illegible]8	492	574	711	704	747	760	824	924
Total number of units elaborated by the mixture (in thousands of Lintner units).	4,17	7,10	9,55	12,30	13,96	18,81	20,28	21,96	22,95	26,37	30,49

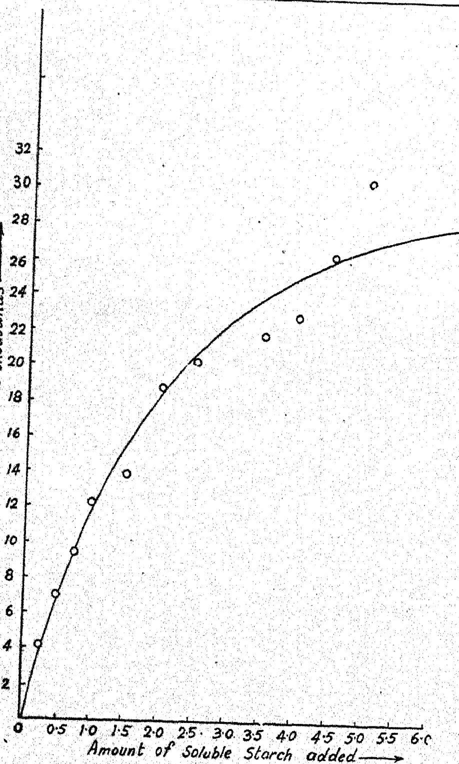

FIG. 2

mass extracted with 25 c.c. of water and the diastatic activity of the extract determined. The results are given in Table I and graphically represented in Figs. 1 and 2. Fig. 1 gives the activity of the preparations from fungi raised on different concentrations of starch; Fig. 2 gives the total quantity of diastase (in Lintner units) elaborated by the different experimental mixtures.

A close study of Table I and the Figures 1 and 2, reveals that with an increase in the proportion of starch, there is a steady increase not only in the purity of the diastase but also in the total quantity of the enzyme formed.

The total quantity of the diastase which is formed in proportion to added starch tends to fall off rapidly after the two per cent. concentration of starch (see Fig. 2). The economic optimum for the ratio of the soluble starch to nitrogen appears to lie somewhere about 7 : 1.

It has been found that starch is completely utilised in all the mixtures so far investigated and the reducing sugar content of the preparations has been found to be insignificant.

Section of Fermentation Technology,
Indian Institute of Science,
Bangalore,
December 25, 1944.

A. N. BINDAL.
M. SREENIVASAYA.

ERGOT AND *SPHACELIAL* STAGES ON SOME WILD GRASSES IN MYSORE

FURTHER studies on the collections of ergot and *Sphacelial* stages occurring on wild grasses were continued some of which have been found to be of interest. A preliminary account of some of them is presented here. On *Digitaria longiflora* Pers., a common grass in the dry waste lands, ergot and *Sphacelial* stages have been observed. Individual spikelets in the inflorescence are affected. Drops of nectar are secreted in the infected spikelets embedding numerous spores. The spores are hyaline, ovate-ellipsoid, asymmetric to slightly arcuate, tapering at both ends and measuring 11·5-16·5 μ × 3-4·4 μ. The sclerotia that are formed later on are black, ovate to spherical, with a brownish white core and measure up to 2-1·3 mm. in size. They resemble very closely *Claviceps digitariæ* Hansf., recorded on *Digitaria scalaris* by Hansford[1] in Uganda. In spite of the lack of germination stages it is probable that the two belong to one and the same species. *Sphacelia* stage has not been described by Hansford for *Claviceps digitariæ*.

Two other *Sphacelial* stages of some *Claviceps* have been noticed round about Bangalore on *Cymbopogon cœsium* Stapf. and *Heteropogon contortus* Beauv. The presence of the *Sphacelia* is indicated in the field by the presence of *Cerebella* which forms greenish-black folded crusts. The spores of the *Sphacelia* on *Cymbopogon cœsium* are hyaline, ovate-cylindric, rounded at both ends, with two conspicuous vacuoles and measuring 9-12·7 μ × 3·5-4·5 μ. The spores of the *Sphacelia* on *Heteropogon contortus* are also cylindric, hyaline, rounded at both ends and measure 11·5-19 μ × 3·5-5 μ. Development of sclerotia has not been observed.

Department of Botany,
Central College,
Bangalore,
January 5, 1945.

M. J. THIRUMALACHAR.

1. Hansford, C. G., *Proc. Linn. Soc.*, 1940-41, 153 Ses., pp. 1-52.

ANOMALOUS VEGETATIVE REPRODUCTION BY CUTTINGS IN *FICUS RELIGIOSA*, LINN.

MANY plants reproduce themselves by vegetative methods, either naturally or artificially. Artificial methods are often resorted to by gardeners, foresters, etc., for the propagation of plants of flowering, ornamental and economic importance.

Of the genus Ficus, *Ficus bengalensis* Linn., *Ficus carica* Linn., *Ficus elestica* Roxb., *Ficus Tsiela* Roxb., etc., are propagated from stem or branch cuttings. So far as the author is aware, *Ficus religiosa* Linn.—a plant which is held in great veneration by the Hindus—is propagated from the seedlings only and not by means of cuttings.

Every year several cuttings of this plant are used as supports to various climbers grown for the class work in the College Botanical Garden. But this year it is found that out of twenty such cuttings only five are found to sprout into leaves and grow in order to produce fresh complete plants. These cuttings were cut down as usual at the end of the month of May and kept for use as supports to climbing plants later on in the monsoon. Remarkable thing about them, this year, is that one of the pieces while lying on the ground gave rise to adventitious roots from one of the cut ends. These roots appear to arise from the region of cambium between the central mass of wood and the peripheral region of the bark. In the beginning of the month of August when these pieces were taken in use, that one which had developed adventitious roots was used after cutting off 18-inch piece from it together with those roots.

The phenomenon of sprouting was noticed after 15 to 20 days in different pieces. This was thought at first to be of temporary nature due to the stimulus given to the buds to sprout, and thereafter to dry up and die. But this did not prove true as these cuttings have struck roots and are able to put forth more of vegetative shoots. The table below gives the circumference just above the ground, height and the number of new shoots on those five cuttings. Mention should be made that these pieces were all branched and some of these branches have dried up while others are alive.

No.	Circumference	Height	No. of new shoots
1	11″	5′—6″	225
2	6·5″	8′—2″	100
3	8″	5′	90
4	7·5″	7′—1″	66
5	8·5″	8′	20

Regeneration is wide-spread among plants. An organ which has been lost is replaced either by formation of a new one in the vicinity of the wound or the outgrowth of one which was in a rudimentary condition. The capacity to form roots is also wide-spread. After roots have developed the stem gives rise to a complete plant either by the unfolding of axillary buds or by development of new growing points to shoots. For all these what is required is a suitable environment.

This year Junagadh had an abnormal weather during the monsoon. Daily several showers of rain continued for nearly two months. There was very little of sunshine during these days, owing to the sky being overcast with clouds. The atmosphere and the soil remained moist all throughout.

This phenomenon may be attributed to this abnormal weather during the monsoon of this year, but what about the development of adventitious roots on one of these cuttings in the dry hot days of the months of May and June? Hence these can only be taken as some abnormal cases.

In this plant, abnormalities have been recorded by Mallik[1] and Singh.[2]

Bahauddin College,
Junagadh, G. A. KAPADIA.
September 26, 1944.

1. Mallik, P. F., "Development of roots from the petiole of *Ficus religiosa* leaf," *Curr Sci.*, 1934, **3**, 105. 2. Singh, T. C. N., "Notes on the Teratology of certain Indian Plants," *Jour. Ind. Bot. Soc.*, 1931, **10**, 135.

CENTENARY OF SIR PATRICK MANSON

THE Centenary of Sir Patric Manson, "the father of tropical medicine" (1844-1922) was marked by a special meeting on Thursday (December 14) at Manson House, Portland Place, of the Royal Society of Tropical Medicine and Hygiene.

Sir Philip Manson-Bahr (his son-in-law) gave an illustrated address on the "Manson saga" and recounted the remarkable career of the young Aberdeen graduate who emigrated to Formosa in 1865 and in 1894 formulated the mosquito-malaria theory, establishing five years later the London School of Tropical Medicine with the aid of Joseph Chamberlain.

This school has suffered much as a result of the war. Most of its activities have been suspended and the Hospital for Tropical Diseases has been destroyed and disbanded. The importance of tropical medicine is now greater than ever and an early rebuilding of the hospital in London becomes more necessary for the benefit of sufferers from tropical disease as a result of the war in the Far East.

It is hoped to found a research scholarship in tropical medicine as an additional memorial. Sir Philip Manson-Bahr appealed for the preservation and extension of Manson's work and Dr. G. Carmichael Low spoke of his dying wish for the establishment of a research scholarship. Other colleagues and friends added their personal testimonies. Manson's diary of original drawings and preparations were exhibited.

REVIEWS

Principles of Physical Geology. By Arthur Holmes. (Thomas Nelson and Sons Ltd., London), 1944. Pp. 532, with 95 plates and 262 text illustrations. Price 30 shillings.

Britain, to whose scientists so much of the pioneer work on physical geology is due, has not in recent years been responsible for the publication of outstanding books on this subject. It was almost as if the fullness of the stratigraphical and igneous record, and the consequent diversity of scenery, notwithstanding the smallness of scale, had led to a complacent acceptance of the wealth of material within, and a neglect of the wonders outside. The book under review has come opportunely to counteract this apparent tendency. It has the catholicity of outlook which is to be expected of an author whose research has for years been connected with the age of the earth. Many will long have had in their possession a small booklet by Professor Holmes, published by Benn for the price of six pence, pennies which were never better spent. The new book is sixty times that price and will be beyond the means of most Indian students, but it is one which every University and Library in the country should have.

It is impossible within a short notice to discuss all the subjects encompassed within the 21 chapters. Part I, of seven chapters, is entitled a preliminary survey, and deals mostly with the materials of the crust. Part II, nine chapters, discusses the external processes responsible for the various types of landscape. Part III, five chapters, is an account of internal processes:—earthquakes, mountain building, plateux and rift valleys, volcanic activity and continental drift. It is not, indeed, the titles which are new, but the manner of presentation, based on the latest work such as gravity determinations in the Caribbean and Dutch East Indies, the coral reef problem, alpine geology, volcanic observations in the island of Hawaii and Professor Holmes' own researches. The impact of original thought is manifest throughout the work.

One of the most striking features of the book is the superb collection of plates and illustrations, taken largely from Europe, North America and South Africa. Many of the photographs are aerial views, from the oblique perspective of which a better impression can be obtained of certain phenomena than from any ground angle. Each chapter contains a recent bibliography.

References to India are relatively few, probably because so much of the work in India is published in official memoirs and records, and photography, particularly from the air, has been neglected. Two problems may be selected for comment. It is possible that the K'un Lun mountains represent the northward overthrust zone separated from the southern Himalaya by the presumed median mass of Tibet (Fig. 199, p. 382), but the recent work of Heim and Gansser indicates that counter-thrusts, dipping south, occur south of Kailas and the greater part of the Tibetan plateau. Further, while the idea of isostatic uplift arising from erosion in the Himalaya is not in dispute, the questions of the origin of the river system and the clusters of high peaks in the Karakoram, eastern Kumaon and eastern Nepal is still perhaps unsettled. The recent work of S. L. Hora on the fish faunas of rivers in India and Tibet, and some observations of Griesbach many years ago in the Kumaon, do not support the view of the antecedent drainage of some, at least, of the Himalayan rivers (p. 200), but suggests that it was consequent. Cross warps along an old peninsular N.E.-S.W. grain may possibly, moreover, be involved in the origin of the Kumaon and Nepal clusters of high peaks. These are minor points in a book dealing with the earth as a whole, in which lack of space necessarily prevents a detailed discussion of all the facts.

The type, paper, and reproduction of the plates are a special credit to the publishers after five years of war conditions.

J. B. A.

Inorganic Chemistry. By P. K. Dutt. (H. Chatterjee & Co., Ltd., 19, Shyama Charan De St., Calcutta), 1944. Pp. 245. Price Rs. 2.

In writing this book, the main object of the author has been to present a concise account of elementary principles of inorganic chemistry to meet the needs of students appearing for the Intermediate Examinations of the Indian Universities. It is highly gratifying to note that the author has fully realised his ambition. The first ten chapters deal with the general and theoretical chemistry, the next twelve with non-metals and the last eight chapters are devoted towards a brief description of metals and their compounds. Invariably, at the end of each chapter, a number of questions pertaining to the topics of the chapter are given. A good number of typical chemical problems are also worked out in the text. One special feature of the book is the grouping up of the metallic compounds like nitrates, chlorides, sulphates, etc., instead of the classical method of describing them under the respective metals. The new system evidently removes a good deal of unnecessary taxation on the memory of the student. At the same time it facilitates the remembrance of the more fundamental general characteristics of the metallic compounds. Although the student may find it difficult to follow certain portions of the book at the very first reading, yet this difficulty vanishes after he attends the class lectures. The author should be particularly congratulated on reducing the cost of the book to such a low value as Rs. 2. It is hoped that the students will be greatly benefited by the low cost of this valuable book.

A few suggestions have to be made to improve the book further. Certain topics like arsenic, arsenic compounds, Morley's method of composition of water, have to be dealt with in this book since they are included in the Intermediate syllabus. It is desirable to

include figures for certain important portions like the preparation of ozone, manufacture of iodine, Dumas method for the composition of water, etc. The author has devoted too much of space to describe some obsolete methods of manufactures like the Weldon's and Deacon's processes for the manufacture of chlorine. Actually the modern practice is to manufacture hydrochloric acid from the electrolytic chlorine and not the *vice versa*. The proof-reading must be done more carefully in the next issue and the mistakes that have appeared on the pages 31, 95, 105, 111, 115, 116, 130, 136, 155, 159, 160, 174, 198, 207 and 221 should be avoided. M. R. A.

Thomas Jefferson and the Scientific Trends of His Time. By Charles A. Brownie. (*Chronica Botanica*, Waltham, Mass., U.S.A; and Macmillan & Co., Calcutta), 1943. Pp. 63. Price 1.25 dollars.

Thomas Jefferson, patron-saint of American democracy, author of the Declaration of American Independence drafted by him in 1776, father and founder of the University of Virginia. and philosopher, was the third (and twice) President of the United States. That he was also a man of science and naturalist is perhaps not so well known outside the U.S. This scholarly essay by the Dean of American Agricultural Chemists deals with his relationships to the scientific trends, especially those pertaining to Natural History, of his times. As an agriculturist, astronomer, architect, botanist, meteorologist, etc., he considerably influenced subsequent developments in American science and that influence will continue to be felt for a long time. His familiarity with many phases of scientific knowledge which was largely utilitarian is well illustrated by his "Notes on the State of Virginia".

The author of the present contribution has successfully tried to follow the scientific ideas of Jefferson back to their sources and in so doing he has illustrated them by extensive quotations from Jefferson's own writings. As a history of the development of American science, the book is very interesting. M.

The Genera of Uredinales with Citations. By Bisby, G. R. (Imperial Mycological Institute, Kew, England), 1944. Pp. 22. One shilling.

This is a list of all the genera of rusts published since 1801 and up to the end of 1943. Rusts are the most important and interesting among fungi and to a mycologist working in a country whose rust flora is not well known, taxonomy presents many difficulties because of the very large number of genera and species involved. Of the former, the author states that 234 names have so far been proposed.

The genera are arranged in alphabetic order with full citations, dates and the type species whenever possible. No other book has brought together under one cover all the rust genera that have so far been proposed. About 63 names not found in Clements and Shear's *Genera of Fungi*, published in 1931, are cited here although the number of new genera published since that date is only 20.

It is a pity that the author decided not to include comments concerning synonymy and life-cycles. At least those genera which by a majority consent are synonymous, should have been placed in italics (underlined in a mimeographed publication). The author cites *Maseeella* as a monotypic genus. This is an error for Sydow proposed a second species in 1928 and two more have been established by Thirumalachar in 1943. With the exception of Saccardo (Vol. VIII, p. 600), all other mycologists, including the present author, have ignored Rabenhorst's genus *Sarcorhopalum* in *Bot. Zeitung*, 1851, p. 627, the species *S. tubiforme* being found on *Aspidium curvifolium* in the Nilgiris. The reasons for its neglect are not clear.

It is hoped that a new edition in a printed form will soon be published. M.

SCIENCE NOTES AND NEWS

Lady Tata Memorial Trust Scientific Research Scholarships, 1945-46

The Trustees of the Lady Tata Memorial Trust are offering eight scientific Research Scholarships of Rs. 150 each per month for the year 1945-46 commencing from 1st July 1945. *Applicants must be of Indian Nationality and Graduates in Medicine or Science of a recognised University*. The subject of scientific investigation must have a bearing either directly or indirectly on the alleviation of human suffering from disease. Applications must reach by March 15, 1945. Further particulars can be had from the Secretary of the Trust, "Bombay House," Bruce Street, Fort, Bombay.

At a recent auction in the Argentine, Argentine-grown jute fetched on an average about Rs. 261 per maund, reports the December issue of the *Indian Central Jute Committee Bulletin.* It was the first lot of its kind to be placed on the market, consisting of six bales of 25 kilos each—a kilo equivalent to about a seer. It was regarded rather as a demonstration than as a commercial transaction. The total procedes amounted to Rs. 1,043-4-0, and they were donated to a charitable fund. The jute offered in the sale was obtained from fields which have been planted with it in the islands of Ibicuy in the delta of the Parana River where it empties into the Rio de La Plata Estuary above Buenos Aires. The sale aroused a certain amount of interest as illustrating the possibilities of jute production in the Republic. Not only in this district of Ibicuy, but in others farther north in Missiones and Corrientes

experimental plantings have been made and the National Bank has interested itself to the extent of granting loans to the colonists willing to take part in the movement.

The Mining, Geological and Metallurgical Institute of India held its Thirty-ninth Annual General Meeting in the rooms of the Royal Asiatic Society of Bengal at 11-30 a.m. on Friday, January 12th, 1945. After the Honorary Secretary had read the Annual Report of the Council which showed that the Institute had had a successful year, the new Council was elected. Mr. B. Wilson Haigh, M.I.chem.E., who, for several years, has been Honorary Secretary of the Dhanbad Branch of the Institute, was elected President for the forthcoming year; *Vice-Presidents*: Mr. L. J. Barraclough, Dr. H. Crookshank and Mr. B. Sen; *Honorary Treasurer*: Dr. H. Crookshank; *Honorary Editor*: Mr. E. J. Bradshaw; *Local Secretaries of Branches*: Dr. C. Forrester, Dhanbad Centre; Mr. J. H. Patterson, Asansol Centre; Dr. J. Sanjana, Jamshedpur Centre; Mr. T. A. Wellsted, C.P. Branch; and Mr. A. Reid, *Honorary Secretary*. In accordance with a new arrangement, the retiring President, Mr. R. A. MacGregor, C.I.E., M.I.Mech.E., Chief Metallurgist to the Government of India, presented his Presidential Address at the end of his term of office. After referring to the tragic loss the Institute had sustained by the death of its Honorary Treasurer, Dr. E. L. G. Clegg, Director of the Geological Survey of India, Mr. MacGregor chose as the subject of his Address, "The Place of the Technical Institutions in the Schemes for Post-War Development of Industry in India".

The Indian Botanical Society has elected the following Office-bearers for the year 1945:—*President*: Dr. N. L. Bor; *Vice-Presidents*: Prof. H. Chaudhuri and Dr. B. P. Pal; *Secretary*: Dr. S. N. Das Gupta; *Treasurer and Business Manager*: Dr. A. C. Joshi; *Elected Members of the Executive Council*: Dr. P. L. Anand, Dr. M. O. P. Iyengar, Prof. G. P. Majumdar, Dr. P. Parija, Prof. M. Sayeed-ud-Din, Prof. T. S. Raghavan, Prof. R. L. Nirula, Dr. T. S. Mahabale, Prof. L. N. Rao, and Prof. F. R. Bharucha; *Editorial Board*: Prof. S. P. Agharkar, Prof. H. Chaudhuri, Prof. M. O. P. Iyengar (Editor-in-Chief), Dr. P. Maheshwari, Dr. A. C. Joshi, Dr. S. N. Das Gupta, and Prof. G. P. Majumdar.

MAGNETIC NOTES

Magnetic conditions during December 1944 were slightly more disturbed than in the previous month. There were 19 *quiet* days, 9 days of *slight* disturbance, 2 days of *moderate* disturbance, and one day of *very great* disturbance, as against 11 quiet days, 19 days of slight disturbance and one day of moderate disturbance during the same month last year.

The quietest day during the month was the 7th, and the day of the largest disturbance the 16th.

The individual days during the month were classified as shown below:—

Quiet days	Disturbed days		
	Slight	Moderate	Very great
1, 3-12, 19-25, 31	2, 13-15, 18, 26, 28-30	17, 27	16

A magnetic storm of great intensity with a sudden commencement was recorded during the month. No magnetic storms occurred during the same month last year.

The mean character figure for the month of December 1944 was 0·48 as against 0·68 for December last year.

M. PANDURANGA RAO.

We acknowledge with thanks receipt of the following journals:—

"Journal of the Royal Society of Arts," Vol. 92, No. 4678; Vol. 93, No. 4680.

"Journal of Agricultural Research," Vol. 69, Nos. 4, 5 and 6.

"Indian Journal of Agricultural Science," Vol. 13, Pt. 3; Vol. 14, Pt. 2.

"Journal of the Indian Botanical Society," Vol. 23, No. 3.

"Calcutta Review," Vol. 94, No. 1.

"Journal of the Indian Chemical Society," Vol. 21, Nos. 8-9.

"Endeavour," Vol. 3, No. 12.

BOOKS

Your Food. By M. R. Masani. (Messrs. Padma Publications, Ltd., Lakshmi Buildings, Sir Pherozeshah Mehta Road, Fort, Bombay), 1944. Pp. viii + 82. Price Rs. 1.

The Royal Society, 1660-1940. By Sir Henry Lyons. (Cambridge University Press, Bentley Home, 200, Euston Road, London, N.W. 1), 20-11-1944. Pp. 324. Price 25/-.

Flowers in Britain. By L. J. F. Brimble. (Macmillan & Co., St. Martin's St., London, W.C. 2), 1944. Pp. x + 393. Price 12/6.

CORRECTIONS

Vol. 13, No. 12 (December 1944)

Article entitled "Classification of Pre-historic Sites in India"—

P. 303, column 1, line 20: there should be a full stop after the word "Krishna". Then the next sentence should read as "They are also abundant in South India."

P.306, column 2, line 40: *read* "work" *for* "dork".

P. 307, column 2, line 21: *read* "Wood" *for* "Woo".

Note entitled "Tonic Elongation of Unstriated Muscle"—

P. 311, column 2: the first line should *read* "It could not only be due to" *instead* of "it could not be due to".

Note entitled "The Thermal Decomposition of Mercuric Fulminate"—

P. 315, column, 1, line 16: *for* "result" *read* "results".

P. 315, column 1, line 27: *for* "Hg_2" *read* "Hg_3".

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CURRENT SCIENCE

Vol. XIV] FEBRUARY 1945 [No. 2

THE INDIAN RICE COMMITTEE ACT

IN November 1944, Mr. J. D. Tyson, Secretary, Education, Health and Lands Department of the Government of India, introduced a Bill before the Central Assembly to provide for the creation of a fund to be expended by a Committee specially constituted for the improvement and development of the cultivation, production and marketing of rice and rice products. The fund was to be made up by the levy and collection of a cess on all rice hulled in any power mill in British India at the rate of six annas a ton. The Central Rice Committee to be constittued is to consist of 51 members of which 14 will represent rice-growers, another 14 the rice industry and trade, and 5 the consumers, the rest forming the technical officers of the Provincial and Central Departments of Agriculture. The main object of the Bill is to put rice research, development and technology on a more permanent basis than it stands at present. There cannot be any difference of opinion about rice being of great importance not only as an agricultural crop but as the principal food of a very large proportion of the population of the country. The Bill has been drawn up on almost the same lines as for cotton, jute, coconut, etc., for which such Central Committees have already been constituted.

In introducing the Bill Mr. Tyson explained how India had never been self-sufficient with regard to her rice requirements and how internal production had been supplemented by imports chiefly from Burma, to the extent of an average of about two million tons a year. The two large rice provinces, Bengal and Madras, were the ones that were utilising these imports chiefly, and the non-availability of the imports has affected the food position here more seriously than in others. The Bengal Famine of 1943 had clearly demonstrated how less adaptable was the rice-eating population than those whose staple diet was wheat or millets, and anything that affected the quantity of rice available was apt to have repercussions much more serious and immediate than a comparable shortage in any other foodstuff. He also said that the population of the country was increasing, more particularly in the rice-consuming areas, and the necessity for the country to develop her protective foods like milk, vegetables, fruits, etc., was dependent upon releasing more area for these and this could become possible only by increasing the acre out-turn of food crops, chiefly rice. The present low acre yields in rice can be improved only as a result of intensive research in all aspects and making the results of such research available to the rice-growers. Although a certain amount of work had already been done in some provinces on their own and in others through the help of the Imperial Council of Agricultural Research much more yet remained to be done before an all-round improvement of the position can be attained. Even with regard to one of the important items of improvement, namely, the spread of the improved varieties evolved by breeding, the statistics available showed that only six per cent. of the rice area had been covered by improved varieties. The production of more food in the country was a crying need and any measure undertaken to increase the output of rice should go a long way to meet this need. Mr. Tyson also stated

that the Rice Committee of the Imperial Council of Agricultural Research where all interests were represented and the Government of India's Agricultural Policy Committee had recommended the establishment of a Commodity Committee for rice. It was only with a Statutory Committee properly constituted with a permanent source of revenue of its own, he said, could a comprehensive programme of research could be planned ahead and put on a permanent basis. The setting up of Commodity Committees was nothing new and the excellent work done by such Committees, say the one for cotton, was a sufficient justification to expect similar work to be done for rice when a Special Committee was formed.

As regards the cess itself, it was stated that only 27 per cent. of the country's rice production came to the mills and the levy of 6 annas per ton of rice amounted to less than 1 pice per maund of rice and even this infinitesimal burden affected not all the people but only those that consumed milled rice. The levy was likely to make available to the Committee a gross revenue of 24 lakhs of rupees every year and it would form a substantial sum for the Committee to start planning out its work. The proposals had previously been circulated to all Provincial Governments who had all agreed and the suggestions put forward by some of them had been incorporated in the Bill. It was mentioned that while one of the Provinces considered that the cess would not provide sufficient funds for a comprehensive work which the importance of the crop demanded, another Province, Bihar, had withdrawn its support to the Bill with a statement that rice was not a valuable commercial crop and the cost of research for its improvement should, therefore, more properly be supported by ordinary revenues. Moving for a Select Committee to examine the Bill, Mr. Tyson hoped that the Bill would go through as soon as possible and that the Committee properly constituted would start functioning before another rice season began in 1945.

The immediate reference of the Bill to a Select Committee was, however, not accepted by the Assembly, there being several amendments suggesting circulation of the Bill by various dates. In the discussion that followed the introduction of the Bill, several members raised serious objections to the Bill while certain others strongly supported it. There was practically a unanimity of opinion in the Assembly with regard to the importance of the crop and of the necessity for research in it in all aspects and the objection taken was with regard to the constitution of the Committee and the terms of the Bill. They pleaded for circulating the Bill to give time for the public and various interests concerned to have their say in the matter so that, if necessary, the Bill may be re-drafted and introduced again.

The main objection against the Bill was with regard to the method proposed for financing the Committee. It was stated that rice being a food crop and not an industrial crop like cotton, jute, coffee, etc., and involved millions of small growers, the levy, however small it may be, will add to the burden of taxation. In support of this contention the report of the Royal Commission on Agriculture was mentioned where they had not suggested Special Committees for food crops. It was mentioned that the improvement of the rice crop should be the main concern of Provincial Governments and while some members were against the levy of any cess, others suggested that Government, to show their interest and responsibility, should contribute an amount to the Committee equal to what is collected as cess. With regard to the representation of the different interests in the Committee there was conflict of opinion; while some thought that rice trade and industry was over-represented others thought that the representation was not sufficient. The objection that was voiced unanimously by the opposition was against Government's nominating growers' representatives on the Committee although they did not put forward any suitable alternative method. It might be mentioned in this connection that in a similar Commodity Committee, namely, cotton, this has been the method followed ever since the Committee was formed and so far as we know, we have not heard that the method has not worked satisfactorily and that the growers' interests have suffered in any way on that account. The point raised by a Bengal representative that his Province does not get sufficient representation in comparison with the acreage and output of the crop in his Province is not strong for the simple reason that its contribution to the fund will be comparatively very much less than from another Province like Madras. While the production in Madras may be only half of Bengal's, nearly 62 per cent. of that production comes to mills and so become subject to the cess, whereas, only 16 per cent. of Bengal's production comes to the mills. The table below gives the average rice acreage and production during the last four years, and gives an idea of the relative importance of the different Provinces with regard to their contribution to the rice fund as proposed in the Bill.

Provinces	Rice area in acres	Rice production in tons	Quanity coming to the mills in tons	Amount of cess contributed in rupees
	in thousands			
Assam ..	5275	1831	366	137
Bengal ..	23614	8655	1380	518
Bihar ..	9335	2877	288	108
Bombay ..	2001	797	437	164
C. P. & Berar ..	5769	1408	422	158
Madras ..	10517	4921	3050	1144
Orissa ..	5027	1329	133	50
Punjab ..	1050	354	318	119
Sind ..	1329	448	405	152
United Provinces	7038	1783	125	47

If it is conceded that to develop rice research in a comprehensive way there should be a Central Committee formed with funds of its own, the method of obtaining the fund sug-

gested in the Bill is the least complicated and an equitable one and it is difficult to think of a better method. In the case of the Cotton Committee, the cess is collected on the bales arriving in all the mills and the contribution each cotton Province makes to the cotton fund will depend on the quantity of cotton produced by it. Although this figure should vary from Province to Province there is no special additional representation to Provinces that produce more cotton. So long as the utilization of the fund to finance schemes of research or extension put up by the Provinces to the Committee is made to depend upon the soundness and practical utility of the schemes, the contributions the Provinces individually make to the common fund need not be a factor to decide the proportion of representation. One would naturally expect that Provinces which contribute largely to the fund because of the comparatively greater importance of the crop to them would have larger number of problems to tackle for which they will seek the financial assistance from the Committee.

Mr. Tyson did no doubt try to answer most of the objections raised in his concluding remarks and to satisfy the demand that the provisions of the Bill should be more widely known to the public, agreed to have the Bill circulated up to 28th February 1945. It was clear from the speeches of Mr. Tyson as well as that of the Hon'ble member in charge of the Department who also took part in the discussions, that they would be quite willing to consider any constructive suggestions to improve the Bill. Let us only hope that the re-drafted Bill would meet with the approval of the Assembly and be passed unanimously when next it comes before it as we are sure that the formation of the Committee will go a long way to improve the present unsatisfactory position of rice in the country.

In this connection it will not be out of place to consider briefly the position of rice research in the country. The table given earlier gives an idea of the relative importance of the rice crop to the different Provinces. Taking into consideration the major rice Provinces, it was only in Madras and Bengal, we learn, that rice research formed an important item among the activities of the respective Provincial Agricultural Departments from a very long time. Even here, Madras was spending much more every year in rice research than Bengal. Among Provinces where rice is not such an important crop, it was only in Bombay and the Punjab definite independent schemes of research have been in progress. Rice research was almost a neglected subject in Provinces like Bihar and Orissa, United Provinces and C.P. and Berar in spite of the relative importance of the crop to them until the Imperial Council of Agricultural Research came into existence. What little has been done in these Provinces has been the outcome of the initiation and financial help provided by the Imperial Council of Agricultural Research during the last ten to twelve years. That an important Province like Bihar (third in its rice area and production) should have remarked that rice was not a commercial crop is regrettable. If the past record is any indication of the interest taken in rice research in some of the Provinces, no great developments need be anticipated if the whole question was left entirely to the Provinces themselves. The present crisis in the country has more than emphasised the necessity for an all-India policy in the matter of food production and when once this necessity is recognised by the legislature there cannot possibly be any opposition coming against the formation of a Central Committee for this most important food crop.

While results of rice research already available in some Provinces are considerable, particularly with reference to breeding improved varieties, there is still considerable scope for further intensifying it for the country as a whole. Before this could be undertaken satisfactorily, a good deal of fundamental research on the genetics of the plant is essential. Similarly, research is needed on the physiology and nutrition of the rice plant. Exploration of the key regions and making use of the wild types in hybridisation work which has been so successfully done in other countries for other crops has yet to be undertaken for rice in India. All these investigations the results from which would be of immediate value to work in the Provinces will, we expect, come under the purview of the Central Committee to be formed. It has been recognised that the centre must take the lead in many matters if progress is to be rapid and the proposals to institute Central Commodity Committees is only a logical sequence of such a recognition. The Committee, when formed, will not merely be a body to co-ordinate work done in the Provinces as was mentioned by a member in the Assembly. We expect that the Committee once formed will immediately take up the question of starting a Central Research Station where the different problems of research mentioned above will be undertaken. The results of such research should be of immediate benefit to the rice-growers. Research work on technological side is bound to be of use to the milling industry. Besides, on an analogy of the Indian Central Cotton Committee, the Rice Committee, when formed, can be expected to be an authoritative body to express any opinion on various matters concerning rice for the country as a whole. There is no reason for any apprehension that the interest of the rice-grower might suffer in the post-war period as was mentioned by an opposition member in the Assembly. In the working of the Indian Central Cotton Committee, we learn that every proposal that comes before it is always considered from the point of view of the interest of the cotton-grower and we may be sure that with a greater representation of the growers in the Rice Committee, than even in the Cotton Committee, their interests could never suffer. We hope that the Rice Bill when it comes before the Assembly again will be strongly supported and passed without any further delay as we feel that those who oppose this Bill will be unconsciously doing a disservice not only to the rice-growers but to the food policy of the country as a whole.

INDIAN SCIENTISTS' DELEGATION ABROAD

CURRENT SCIENCE (December 1944) briefly noticed the activities of the Indian Scientists' Delegation in the United Kingdom and recorded its arrival in Washington on the 11th December 1944. Recent press messages indicate that the Delegates had completed their eight-weeks' programme in the States and private advice since received expect the Delegation back in India sometime during the third week of this month (February).

An extensive tour for the Delegation had been arranged by the State Department and the Indian Agent-General whereby the members visited the leading American Laboratories of the Industrial Establishments, the Universities and of Government Departments. The general impression of the Delegation may perhaps be best summarised in the words of Sir J. C. Ghosh who, at the conclusion of this countrywide tour, commented as follows to a press representative at Washington: "The scientific research laboratories of the United States appear to be the best equipped by men of outstanding ability and high distinction. Fifty years ago, young Americans of great ability were sent in large numbers to scientific laboratories in Western Europe for training and research. To-day, America is outstanding in the field of scientific discovery and the trend is in the other direction. We were particularly impressed with the research laboratories in the United States' industries. Much of the work done there is of a fundamental nature although a considerable portion of the work relate to immediate industrial problems. The equipment in the science laboratories and the men in charge of them and the funds at their disposal are far superior to what we have seen in other parts of the world. As a matter of fact, in no laboratory we visited was the annual expenditure less than five million dollars."

It is specially gratifying to learn from the leader of the Delegation, Sir S. S. Bhatnagar (who told reporters in New York) that the Mission was "particularly successful in contacting big business and in seeing the most advanced modern research laboratories in the world" and that they had "collected information which will be of great interest to Indian industry and Government".

The case for American assistance to Indian economic expansion was succinctly put by Dr. Nazir Ahmad in his speech at the Lunch given to the Delegation by the Advertising Club of New York which includes some of the most outstanding American industrialists and business executives. Dr. Ahmad gave three reasons: "First, the world is a small place today and an undeveloped country remains a potential source of economic disruption. If developed, it will become a profitable market for highly industrialised countries. Secondly, India and America have been brought close together by bonds of commonly shed blood in defence of liberty and human rights. These bonds must not be allowed to break. Thirdly, the United States recognises the necessity of living with the rest of the world as equal members of one community."

The successful conclusion of the Mission's visits to the United Kingdom and the United State should not blind one to the fact that practical results of immediate consequence to Indian science and industry will depend on the action taken by the authorities here after the Delegates return home. The members have had exceptional opportunities of seeing what is being done by two of the leading Nations in the world in fostering science. They have also acquired first-hand knowledge of the possibilities of training our own men in the renowned scientific institutions of these two countries. And they do know in great detail the exact requirements of Indian science and the lacunæ in our scientific organisation. It is therefore but natural that great hopes should be raised by these visits of the Delegation. May they soon come to fruition!

These hopes are strengthened by evidence pointing that Indian authorities have already begun taking action in some directions. Thus recently there appeared a press communique announcing the outlines of a scheme by the Government of India to train 500 students abroad in several branches of science and technology. Again, Sir A. V. Hill, speaking at the Royal Society (31-1-1945) stated that "It seems likely that the Government of India will set up an Indian Scientific Office in London. Possibly even an Indian Scientific *Liaison Service* will be established with its headquarters in Delhi, its main overseas office in London and branches in other countries."

These schemes no doubt cost money. In this connection, it is interesting to recall the suggestion made that part of the Indian accumulation of sterling in England should be utilised for this purpose—the *Manchester Guardian* going so far as to say "... But if Indians are wise they will take as much payment as they can in coin of knowledge. Education and training of Indian research workers and technicians abroad is an essential condition for the success of the great industrialisation plan."

The outlook for Indian science thus appears to be very bright indeed. Public opinion in India was never more keen than to-day in reorganising the role of science in contributing to the welfare of the country. The money required to finance these schemes is, as the *Manchester Guardian* points out, available. And, in the best traditions of the internationalism of science, the authorities in both the United Kingdom and the United States offer their fullest co-operation in this matter to India. *Current Science* hopes that the visits of our scientific ambassadors abroad will enable Indian science to take the fullest advantage of these propitious circumstances and formulate and translate into action a scheme for the planned development of Indian scientific research.

THE AREAS OF ORIGIN OF LOCUST FLIGHTS IN THE DIFFERENT PARTS OF INDIA WITH REFERENCE TO THE QUESTION OF THEIR CONTROL

BY *Rao Bahadur* Y. RAMCHANDRA RAO

IN the course of the Locust Research Work carried out during the period 1931 to 1939 under the auspices of the Imperial Council of Agricultural Research in north-western India, a great mass of information was collected in regard to locust movements in India during the past locust cycles. These data are at present under study by the writer at Bangalore in correlation with the character of the seasons, the nature of the rainfall and the prevailing wind-directions. A detailed report of the results of these studies will, in due course, be presented for publication. In the meantime, in view of the topical value of the character of locust movements in India, with reference to the question of locust control during the current cycle, a few remarks on the character of locust flights in India are offered in these notes.

SOURCES OF LOCUST OUTBREAKS IN INDIA

Cotes (1891) was of opinion that most of the Indian swarms originated from the Rajputana desert, though he conceded that in the case of flights appearing in north-west Punjab, they should have come from breeding grounds beyond the Sulaiman Range. Webb-Ware (1915), on the contrary, held that the main source of the Indian swarms was the Great Kirman Desert of Persia. The generally held view in the earlier days, however, was that the primary swarms came from the west from beyond the Indian borders, and remained breeding in India for two or more years, until they ultimately perished.

Since 1921, when Uvarov (1921) propounded his theory of phases among locusts, views about the origin of locust swarms have been profoundly modified. According to him, during times when swarms disappeared, locusts reverted to a solitary phase of life and were confined to their breeding grounds, but when under the influence of favourable weather conditions, their numbers were multiplied, they again resumed their gregarious phase existence. During the period 1932 to 1939, when swarms of the Desert Locust were absent in most places or occurred in small numbers, investigations were conducted in many of the locust areas, such as the Red Sea Coast of Sudan, north-west India, and French West Africa, on the ecology of the locust, as a result of which a confirmation of the phase hypothesis was obtained from more than one source, and a great deal of additional knowledge regarding the solitary phase locusts has been gathered. As against the generally held view that solitary phase locusts were non-migratory, it has been found that they react to changes in the environment more or less like the gregarious phase, and are capable of migrating long distances from one rain-belt to another with the change of seasons. The transformation of the solitary phase into the gregarious has been observed to take place in locations where ecological conditions are specially favourable for crowded breeding; and in years inaugurating a fresh cycle of locust infestation, there is little doubt that such centres of outbreak occur over a wide area and that flights originating from such places become fused together to form locust swarms—large or small.

THE GENERAL MOVEMENTS OF LOCUSTS IN INDIA DURING YEARS OF OUTBREAK

Most of the data on locust activities available for various past years in India have been, after analysis with reference to seasons, plotted on maps year by year, and as a result of a study of these maps, the following inferences in regard to the sequence of events observable in most years during the past locust cycles have been drawn.

1. In the case of most of the past locust outbreak cycles, there is a general lack of information on locust activities for areas outside India and, in fact, even for those within Indian limits, in regard to the periods when initial outbreaks had been brought into being, so that it is not possible to make a general statement as to how these are usually caused. From observations made during the last swarmless interval from India, *viz.*, 1932 to 1939, however, there is a great deal of evidence to indicate that the outbreaks in India are set on foot by incursions of groups of locust individuals produced in outbreak centres situated partly in British Baluchistan, and partly (possibly mainly) in Iran and eastern Arabia. In some cases, these incursions may to a certain extent take the shape of regular swarms even at the outset. Such immigrant locusts would breed intensively in the Sind-Rajputana area in case the monsoon rainfall should be favourable, and be able to start a new cycle of swarm infestation in the Indian areas, as in 1926.

2. Except in years in which, as a result of the activity of overwintering swarms, spring breeding occurs in Baluchistan and the Punjab, the season usually starts with the arrival of swarms from the direction of Iran in May-June. The strong south-west winds prevalent at this time of the year generally carry the locusts rapidly across Sind into the Rajputana desert areas, and often beyond into the Punjab, United Provinces and Central India, and even into Bihar and Bengal.

3. In the Ganges valley, the influence of the monsoon begins to be felt from the beginning of June, when easterly winds from the Bay of Bengal gradually advance westwards through the United Provinces into the Punjab. With the development of the easterly current, most of the swarms reaching the United Provinces, Bihar and Bengal are usually swept back westwards so that they tend to become concentrated in western U.P., in eastern Punjab, and in Rajputana at the time of breeding.

4. With the fall of monsoon rains in July, egg-laying and breeding begins in the desert areas of Sind and Rajputana, and in parts of

the Punjab and the United Provinces, and the new generation of locusts is ready to fly by the end of August or the beginning of September. If good rainfall should occur in August and September, the later batches of swarms from the west, and sometimes even the new generation of locusts, may breed in September and October, and the adults of such late broods would be ready for flight only by the end of October and during November.

5 With the withdrawal of the monsoon early in September from north-west India, the Rajputana area and the neighbouring parts of the Punjab and the U.P. become dry areas and locusts tend to leave them, the direction of their flights being determined by the wind movements prevalent at the time.

6. Swarms bred in the Punjab and U.P. areas and in parts of eastern and north-eastern Rajputana usually come under the influence of the strong westerly winds that develop in September-October in the Gangetic valley, and are carried into the United Provinces, Central India and the Central Provinces, and may often reach Bihar, Bengal and Assam in November-December. Swarms reaching the southern parts of Central India and the south-western districts of the Central Provinces are often swept southwards and westwards into Berar, Bombay and Hyderabad by the north-easterly winds that usually prevail in October and November; and some may even reach in certain years the northern districts of Madras under the influence of the northerly winds that sometimes develop at that time. Some of the Rajputana swarms fly south into the Western India States, Kathiawar and Gujarat in October-November, and others, mainly from western parts of Rajputana, fly westwards into Sind, Baluchistan and western Punjab during autumn.

7. In the case of the second or late generation produced in the Rajputana desert areas, the cold weather will have set in by the time the insects assume wings, and owing to the change in the weather conditions, the urge for an immediate migration out of the desert is not so strong as in September-October. Limited migration, however, still continues so that the desert area is generally clear of swarms by the middle of winter.

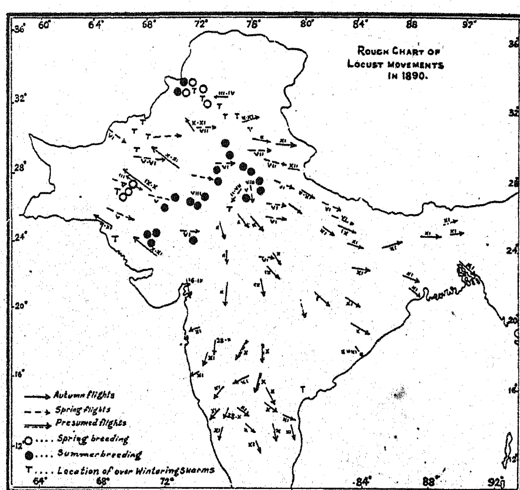
8. In years of late breeding, large numbers of locusts may be found passing the winter in parts of Sind, the Punjab and the U.P., the swarms generally being found in a quiescent condition, or undertaking short migrations during spells of warm weather.

9. Swarms are found in the winter months in other parts of India also in certain years, *e.g.*, Western India States, Bihar, Bengal or even in South India, but none of these ever breed in these areas. On the other hand, those found in the Punjab, Sind and Baluchistan become mature and breed in spring, if the spring rains are favourable.

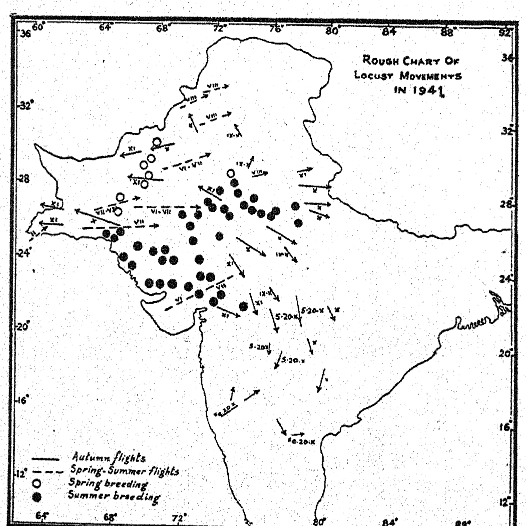
10. The swarms breeding in the spring months of March-April in northern and central districts of the Punjab, are ready to fly by the end of April or the beginning of May, and migrate with the westerly winds that prevail in May-June in the Gangetic valley, towards the east or south-east into the United Provinces, Central India, Central Provinces and Bihar.

11. Swarms of over-wintered yellow locusts migrate in spring from Iran and Oman into Baluchistan (Mekran and Chagai) and breed there in March-April, and the adults emerging therefrom migrate eastwards in May into Sind, Rajputana and the Punjab and thence join the flights of the Punjab-bred migrants eastwards towards U.P. and Bihar. Those breeding in the uplands of north Baluchistan and in the Kandahar and Arghastan areas of Afghanistan begin their flights only later and reach India by about July, while the pink swarms bred in eastern and north-east Iran reach India only much later in July-August.

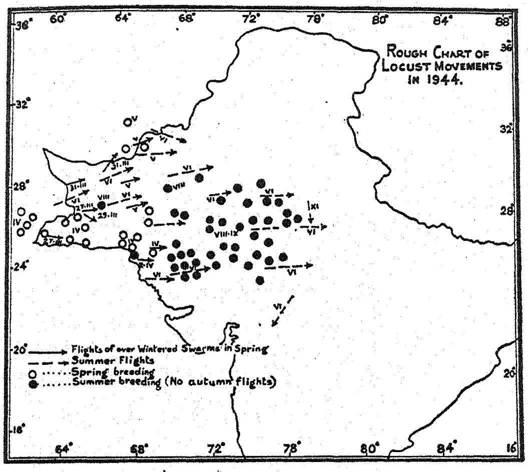
Most of these movements are illustrated in Map No. 1, which shows graphically the locust



MAP 1



MAP 2



MAP 3

situation in India for the year 1890, when flights reached as far east as Dacca and as far south as the Chingleput District in Madras in the autumn.

PAST LOCUST CYCLES IN INDIA COMPARED WITH THE PRESENT OUTBREAK: EFFECT OF CONTROL OF BREEDING CENTRES ON SWARM PRODUCTION

The present cycle of locust infestation in India started in 1940, and Dr. Pruthi (1941, 1944) has given an account of the origin of the new cycle and the progress of the infestation up to September 1941 in *Current Science*, November 1941 (Vol. 10, No. 11) and from October 1941 to June 1944 in *Current Science* (Vol. 13, No. 7). As in the course of the study of the data on the past locust cycles in India, it was found that the work was handicapped by an entire lack of information in certain cases and by insufficient or doubtful data in others, it was hoped that the doubtful points might be elucidated in the light of the fuller data of the present cycle. With the help of the information given in the fortnightly communiques of the Imperial Entomologist on the "Locust situation and progress of control in India", the activities of locusts were, therefore, roughly mapped for the years 1940 to 1944 for purposes of comparison with similar maps prepared for important years of past cycles.

On comparison of the events of past outbreaks with those of the present, however, it was apparent that it was only in the case of the years 1940 and 1941, that locust movements were at all comparable with some of the past years, for it was only in these two years that locust developments in India ran a natural course unaffected by any seriously undertaken control measures. In 1940, flights radiated in autumn from the breeding areas in Rajputana west, north-west, north-east and south-east. In 1941, spring breeding occurred chiefly in Kachhi and Jhalawan. In June-July, locusts appeared from the west in several waves of migration and flew into Sind, Rajputana and Western India States. Good breeding occurred in the Thar area of Sind and in parts of Rajputana, Lasbela and Western India States, during the monsoon months, and the resultant swarms spread in October south-east into Central Provinces, and southwards as far as Belgaum District in Bombay and Bellary District in Madras (*vide* Map No. 2, 1941).

On the other hand, during the years 1942, 1943 and 1944, locust activity was more or less normal so far as spring breeding and spring flights were concerned. From May onwards, swarms from the west from beyond the Indian borders migrated every year into Sind and Rajputana, and in 1943 reached as far east as Bihar by June. There was intensive breeding in the desert areas of Sind and Rajputana after monsoon rainfall, but autumn flights were conspicuous by their paucity, especially during 1943 and 1944 (*vide* Map No. 3, 1944). This circumstance can be attributed solely to the progressively more efficient and well-organized control measures adopted since 1942 in the Sind-Rajputana areas as well as in other provinces where summer breeding occurred.

An examination of the locust movement maps of some bad years of past outbreaks—for instance 1878, 1889, 1890, 1901, 1903, 1929 and 1930—would show that as a result of heavy summer breeding in Rajputana, the Punjab and the United Provinces, swarms had spread during the autumn of these years as far east as Bengal and Assam, and south as far as the northern districts of Madras. The relief from locust depredations afforded to the Provinces and States situated east and south of Rajputana during 1942, 1943 and 1944 should, therefore, be ascribed to the efficiency of the control measures carried out at the right spots under the direction of the Locust Control Organization of the Government of India.

Even in the case of the spring and early summer flights, there is no doubt that the control operations undertaken in Baluchistan, and parts of Oman and Iran and in the Punjab, had apparently gone far towards limiting the number of spring flights from the west into India, but as the greater part of the flights from the west had presumably been derived from spring-breeding areas in Iran and Arabia (possibly even further west from the Red Sea areas), the question of a more thoroughgoing solution of the locust problem in India has assumed an international aspect and is clearly dependent on an organisation of control on an international basis.

1. Cotes, E. C., *Jl. Bomb. Nat. Hist. Socy.*, 1891, **6**, 242–62. 2. Pruthi, H. S., *Curr. Science*, 1941, **10**, No. 11. 3. —, *Ibid.*, 1944, **13**, No. 7. 4. Uvarov, B. P., *Bull. Ent. Res.*, London, 1921, **12**, 135–36. 5. Webb Ware, F. C., *Agr. Jl. India*, 1915, **10**, 1 9–66.

Note.—The cost of printing this contribution has been defrayed by a generous grant from the Rockefeller Foundation for the publication of results of scientific work made to us through the kindness of the National Institute of Sciences, India.—*Ed.*

THE NEW SYMPATHOMIMETIC BASES

INVESTIGATIONS centering round the sympathomimetics have lent themselves to almost rigorous interpretation and made possible the theoretical prediction of the probable physiological properties of a related member fulfilling the structural specifications for sympathomimecity. Nevertheless, these studies have been mostly restricted to members of the benzene series. Since the classical researches of Barger and Dale (*J. Physiol.*, 1910, 41, 19), in 1910, no systematic efforts appear to have been made to explore the sympathomimetic potentialities of the higher poly- and hetero-cyclic ring systems. Rajagopalan and Venkatachalam (*Proc. Indian Acad. Sci.*, 1944, 20, 175) have now biologically examined twenty-one compounds, severally derived from the benzene, naphthalene, acenaphthene, phenanthrene and isoquinoline nuclei. These compounds possess the accepted chemical configurations for sympathomimetic activity; their synthesis had formerly been reported by Rajagopalan (*J. Indian Chem.* Soc., 1940, 17, 567; *Proc. Indian Acad. Sci.*, 1941, 13, 566; 14, 126; 1944, 20, 107). The results obtained by Rajagopalan and Venkatachalam are interesting since they afford an insight into the fundamental relation between constitution and pressor action particularly of the naphthalenic compounds. The rules governing the qualitative and quantitative relation between structure and pressor action of benzenoid sympathomimetics appear to apply to members of the naphthalene series only to a limited extent. The substitution of the benzene nucleus of well-known vasoconstrictors by the naphthalene ring usually results in considerable increased action, but this rule has an exception. The generalisation of Madinaveitia (*Bull. Soc. Chim.*, 1919, 25, 601; *Anal. Fis. Quim.*, 1920, 18, 66) that such substitution augments the activity by over forty times consequently receives only limited support. The postulate of von Braun (Ber., 1916, 49, 2645; 1917, 50, 63) that methyl amino hydrindene owed its high activity to its being *doubly* a β-phenyl ethylamine seems inadequate in view of the feeble activities now evinced by a number of bases which may be considered β-phenyl ethylamines many times over. While the naphthalene and acenaphene nuclei are equal and about seven times as active as the benzene ring, the phenanthrene ring is only twice as effective as benzene sympathomimetically. New potent pressors appear unlikely to be encountered in the benzene, phenanthrene and isoquinoline ring systems, but the naphthalene series appears promising. The active pressor amines of the naphthalene series revealed in a more recent study of Rajagopalan and Venkatachalam (*Current Science*, 1944, 13, 232) are β, β-1:1'-dinaphthyl, β-hydroxy ethylamine, β, 2- and β, 1-naphthyl, β-hydroxy ethylamine, ω-amino, α-acetonaphthone, and β, 1-naphthyl ethylamine. Whether any of these are likely to find a place ultimately in medicine, by virtue of advantages they might possess over the sympathomimetics now in usage in the matter of less toxicity, more prolonged action, etc., can be settled only by their detailed pharmacological examination. There is no doubt that the sympathomimetics constitute a fertile field for further exploratory work by the organic chemist in collaboration with the pharmacologist.

OBITUARY

PROF. J. K. CATTERSON-SMITH

TO all his friends in India and particularly to his old students of the Indian Institute of Science the news of the passing away of Professor Catterson-Smith must have caused great sorrow and to many of them it must have come as a personal loss.

Professor Catterson-Smith came to India in 1922 when he was appointed to the Chair of Electrical Technology at the Indian Institute of Science, Bangalore. The eight years of his stay were marked by considerable expansion of the Department, particularly the introduction of the High Tension and Radio laboratories, which can stand comparison with most other laboratories of similar type in other parts of the world. He was the Founder and President cf the Electrical Engineering Society for eight years running. *Electrotechnics*, the only journal in India devoted to Electrical Engineering, owes its origin to his zeal and enterprise. In recognition of his services the Honorary Fellowship of the Indian Institute of Science was conferred on him.

Professor Catterson-Smith left India in 1930, having been appointed William Siemens Professor of Electrical Engineering at King's College, London, which post he held till his death. In addition, owing to war conditions, he spent the last five years with King's College, at the Bristol University. Professor Catterson-Smith was an admirable teacher and his lectures were greatly appreciated by all his students.

Professor Catterson-Smith was an ardent believer in the industrialization of India and always showed genuine interest in the development of Indian resources. Many factories owe their origin to his initiative as for example the Government Porcelain Factory, Bangalore.

Professor Catterson-Smith was extremely courteous and sweet-tempered and succeeded in winning in a remarkable degree the affection and admiration of all who came into contact with him.

In his death the world has lost an able engineer, India a sincere friend and his students a great teacher and guide.

LETTERS TO THE EDITOR

INTERACTION FORMULÆ IN ANALYSIS OF VARIANCE

1. The methods adopted by J. O. Irwin (*J.R.S.S.*, Vol. 94, 1931) in proving some of the main formulæ in Analysis of Variance indicate that he has missed the proper method of approach to these formulæ. We propose to point out here an extremely simple method of deriving them from a repeated application of the elementary result

$$S(x^2) - n(\bar{x}^2) = S(x - \bar{x})^2,$$

which we rewrite

$$S(x^2) - S(\bar{x}^2) = S(x - \bar{x})^2. \qquad (1)$$

In Irwin's notation for a set of three-way variates x_{uvw} which may be grouped according to u's, v's, w's (uv)'s, (vw)'s and (uw)'s, we get, by applying (1) to the various groups into which the aggregate of x's may be subdivided, the following results:—

$$S(x_{uvw}-\bar{x})^2 - S(\bar{x}_{u..}-\bar{x})^2 = S(x_{uvw}-\bar{x}_{u..})^2 \qquad (2)$$

$$S(x_{uvw}-\bar{x}_{u..})^2 - S(\bar{x}_{.v.}-\bar{x})^2 = S(x_{uvw}-\bar{x}_{u..}-\bar{x}_{.v.}+\bar{x})^2 \qquad (3)$$

$$S(x_{uvw}-\bar{x}_{u..}-\bar{x}_{.v.}+\bar{x})^2 - S(\bar{x}_{..w}-\bar{x})^2 = S(x_{uvw}-\bar{x}_{u..}-\bar{x}_{.v.}-\bar{x}_{..w}+2\bar{x})^2 \qquad (4)$$

$$S(x_{uvw}-\bar{x}_{u..}-\bar{x}_{.v.}-\bar{x}_{..w}+2\bar{x})^2 - S(\bar{x}_{uv.}-\bar{x}_{u..}-\bar{x}_{.v.}+\bar{x})^2 = S(x_{uvw}-\bar{x}_{..w}-\bar{x}_{uv.}+\bar{x})^2 \qquad (5)$$

$$S(x_{uvw}-\bar{x}_{..w}-\bar{x}_{uv.}+\bar{x})^2 - S(\bar{x}_{.vw}-\bar{x}_{..w}-\bar{x}_{.v.}+\bar{x})^2 = S(x_{uvw}-\bar{x}_{.vw}+\bar{x}_{.v.}-\bar{x}_{uv.})^2 \qquad (6)$$

$$S(x_{uvw}-\bar{x}_{.vw}+\bar{x}_{.v.}-\bar{x}_{uv.})^2 - S(\bar{x}_{u.w}-\bar{x}_{..w}+\bar{x}-\bar{x}_{u..})^2 = S(x_{uvw}+\bar{x}_{u..}+\bar{x}_{.v.}+\bar{x}_{..w}-\bar{x}_{.vw}-\bar{x}_{u.w}-\bar{x}_{uv.}-\bar{x})^2 \qquad (7)$$

which last is the sum of squares for second-order interaction. The summation extends over all the variates x_{uvw}. It is assumed that each r-way sub-group of the same kind contains the same number of elements, $(r = 1, 2)$.

2. If the suffixes u, v, w refer respectively to rows, columns and treatments of a Latin Square, the formula for interaction in a Latin Square design is obtained by adding (2), (3) and (4) above, in the form

$$S(x_{uvw}-\bar{x})^2 - S(\bar{x}_{u..}-\bar{x})^2 - S(\bar{x}_{.v.}-\bar{x})^2 - S(\bar{x}_{..w}-\bar{x})^2 = S(x_{uvw}-\bar{x}_{u..}-\bar{x}_{.v.}-\bar{x}_{..w}+2\bar{x})^2 \equiv D, \text{(say)} \qquad (8)$$

If x_{ijk} be any particular variate, then

$$\tfrac{1}{2}\frac{\partial D}{\partial x_{ijk}} = S\left[(x_{uvw}-\bar{x}_{u..}-\bar{x}_{.v.}-\bar{x}_{..w}+2\bar{x})\left(\frac{\partial x_{uvw}}{\partial x_{ijk}}-\frac{\partial \bar{x}_{u..}}{\partial x_{ijk}}-\frac{\partial \bar{x}_{.v.}}{\partial x_{ijk}}-\frac{\partial \bar{x}_{..w}}{\partial x_{ijk}}+2\frac{\partial \bar{x}}{\partial x_{ijk}}\right)\right]$$

$$S = (x_{ijk}-\bar{x}_{i..}-\bar{x}_{.j.}-\bar{x}_{..k}+2\bar{x});$$

since the expression

$$(x_{ijk}-\bar{x}_{i..}-\bar{x}_{.j.}-\bar{x}_{..k}+2\bar{x})$$

vanishes when summed over either the i-th row or the j-th column or the k-th treatment.

Maharaja's College,
Mysore, A. A. Krishnaswami Ayyangar.
September 16, 1944.

SATURATION IN THE *LIGHT-EFFECT* UNDER ELECTRIC DISCHARGE

That the magnitude of this phenomenon, *viz.*, a current decrease $\triangle i$ due to irradiation, increases at first rapidly and then slowly as the

light-intensity I is increased progressively, was observed earlier;[1,2,3,4,5,8,9] as also its pronounced occurrence in a chlorine-filled discharge tube of the *full-* or the *semi*-ozonizer type owing to the large surface exposed. Subsequent results were interesting for Δi due to more than one light-source used simultaneously.

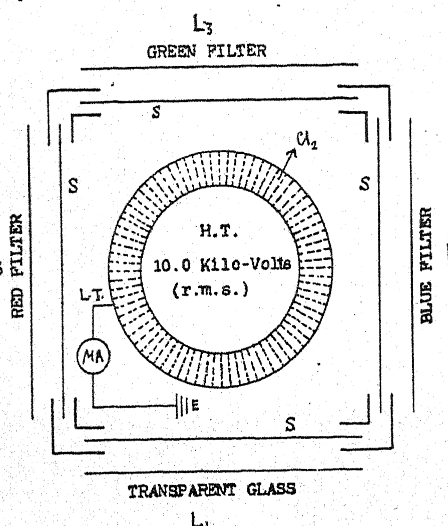


FIG. I

The glass ozonizer, kept at the axis of a rectangular box with movable side-shutters (S in Fig. 1) could be irradiated by one or more of 200-watt incandescent bulbs L_1, L_2, L_3, L_4. At 10 kilo-volts (r.m.s.), Δi corresponded to 29 per cent. with L_1 alone; with $L_1 + L_2$ used simultaneously, Δi increased to 32 per cent.; it was 35 per cent. and 36 per cent. due to the combined irradiation from three and four bulbs respectively. Thus, for about a fourfold increase of I, the light-effect rises from 29 to 36, that is, by 24 per cent.; corresponding to the final 100 per cent. rise in I, that in Δi is only 3 per cent. These results reveal an approach to saturation or some limiting condition. They cannot be ascribed to any 'fatigue' effects familiar in photo-electric phenomena, especially since restoration of the discharge current to its original value in dark after shutting off the light-source at any of the above stages of intensity-variation, was complete and sensibly instantaneous.[1,2,3]

Light filters (glass) fixed as shown in Fig. 1 enabled observations of Δi due to exposure in one or more parts of the spectrum. The light-effect under the unfiltered, *i.e.*, the white light (3700-7800 Å) using L_1 was 29 per cent.; in the filtered blue (4120-4960 Å), green (5100-5780 Å) and red (6000-7300 Å), Δi was 28 per cent., 6 per cent. and 3 per cent. respectively. The light-effect due to $L_1 + L_2$ used simultaneously almost equalled that due to the direct white (*i.e.*, unfiltered) from L_1 combined with the filtered blue from L_2. This is in agreement with the earlier results that the light-effect of the blue component is almost equal to that under the unfiltered white especially at large I due, in part, to saturation. Furthermore, Δi produced under blue (or white) showed no appreciable increase when irradiated in addition, in the green or/and in the red. Similarly, Δi due to green (using L_3 and the filter) was but slightly increased, when irradiated simultaneously with the red (L_4 and the filter). It is generalised that, presumably due to saturation, the light-effect by simultaneous irradiations in different spectral regions is less than the sum of the corresponding Δi produced separately. It is remarkable that this deduction holds for such widely separated regions of the spectrum as the visible and the X-rays.[5]

The above facts are in striking contrast with those characteristic of the classical photo-electric effect, not only in the sense that it entails a conductivity rise but also because the magnitude of the former is affected markedly owing to a simultaneous irradiation in the long-wave region. Thus, for example, in certain cells containing composite surfaces, exposure to the infra-red *decreases* the photo-electric effect by 50 per cent.[6] In numerous cases of photo-conductivity (the volume or internal photo-electric effect), however, a simultaneous exposure in the red or infra-red is known to increase the conductivity by over 100 per cent. This is attributed to a motion towards the cathode of the positive ions left as 'space charge' during the primary irradiation of the crystal. Such a mechanism cannot hold appreciably for the present phenomenon, which is produced predominantly in a gas under electric discharge. The above type of influence on the gas-solid interface presented by the container walls is, however, not unlikely, since the nature of this interface and its immediate neighbourhood are an important determinant of Δi. It may also be emphasised that in notable contrast with especially the surface photo-electric effect, *in vacuo*, the non-linearity of the Δi–I relationship—almost invariably the curve is concave to the *I-axis*—established over a wide range of conditions studied in these Laboratories, can now be taken as a general characteristic of the present phenomenon. This together with the finding that Δi is markedly sensitive to pressure changes of the excited gas[1,2,4] suggests, that secondary effects perhaps of the collision type are superimposed on a primary *quantaic* change in the occurrence of this phenomenon.[1,2]

Benares Hindu University,
Chemistry Department,
November 1, 1944. S. S. JOSHI.

1. Joshi, *Presi. Add.*, *Chem. Sec.*, *Indian Sci. Cong.*, 1943. 2. — *B.H.U. Journ.*, 1943, **8**, 199. 3. —, *Curr. Sci.*, 1944, **13**, 253. 4. — and Deo, *Nature*, **1943**, **151**, 561. 5. —, *Curr. Sci.*, 1944, **13**, 273. 6. Olpin, *Phys. Rev.*, 1930, **36**, 376. 7. Gudden and Pohl, *Zeits. f. Phys.*, 1924 **20**, 14. 8. Deo, *Curr. Sci.*, **1944**, **13**, **44**. 9. Joshi and Deo, *Nature*, 1944, **153**, **434**.

USE OF EVERS' MODIFIED BELLIER'S TEST FOR DETERMINING PERCENTAGE OF ADULTERATION OF SESAME OIL WITH GROUNDNUT OIL

SESAME (til or gingelly) oil is used as principal edible oil in Gujarat and Thana District and groundnut oil is a common adulterant of this oil. After the introduction of The Bombay Prevention of Adulteration Act, we had to experience a great difficulty in ascertaining the percentage of adulteration of sesame oil with groundnut oil. Unless the proportion of adulteration with groundnut oil is determined in sesame oil samples, the Court of Law does not accept the validity of the certificate, the reason being that the Text of Certificate as laid down in the Act, requires that the percentage of foreign ingredient in a particular article of food must be stated in the Certificate and hence the certificate stating only the fact that "the oil sample is not genuine" is liable to be rejected by the Court and this has happened in some cases under this Act. This led us to apply Evers' modified Bellier's Test (for ascertaining percentage proportion of groundnut oil adulteration in olive oil) to ascertain proportion of groundnut oil adulteration in sesame oil. This test is very convenient and reliable for routine work if turbidity temperatures are carefully observed. We carried out a series of experiments by taking a number of samples of pure sesame oil and mixing them with pure groundnut oil in definite percentages and determined the turbidity temperatures corresponding to the different percentages of groundnut oil present in sesame oil. The experimental procedure is the same as outlined in Evers' modified Bellier's test (*vide Tech. Handbook of Oils, Fats and Waxes*, Vol. II, p. 140,—Fryer & Weston, 1920). The following are the comparative results of turbidity temperatures recorded by Evers with respect to percentage of groundnut oil present in olive oil and those recorded by us with respect to the percentage of groundnut oil present in sesame oil.

Approximate percentage of Groundnut Oil present corresponding to Temperatures of Turbidity (Evers)

OIL	Turbidity Temp.
Olive	11·8–14·3°C.
+Groundnut 5%	15·9–17°C.
,, ,, 10%	19·8
,, ,, 20%	25·7
,, ,, 30%	29·2
,, ,, 40%	31·5
,, ,, 50%	33·8
,, ,, 60%	35·3
,, ,, 70%	36·6
,, ,, 80%	38·0
,, ,, 90%	39·3
Arachis	40·0–40·8

Percentage of Groundnut Oil present corresponding to Temperatures of Turbidity (our results)

OIL	Turbidity Temp.
Sesame	15·0 — 16·0
+Groundnut 5%	17·5
,, ,, 10%	19·5
,, ,, 20%	22·0
,, ,, 30%	24·5
,, ,, 40%	27·5
,, ,, 50%	30·5
,, ,, 60%	32·5
,, ,, 70%	34·5
,, ,, 80%	35·5
,, ,, 90%	37·0
Arachis	38·0 — 38·5

The chart of the above results if plotted enables the analyst to determine the percentage of adulteration with groundnut oil in sesame oil very accurately. The turbidity temperature of groundnut oil (obtained by ether extraction) is 38°·0-38°·5 C. The above variations in the turbidity temperatures may be due to variations in the composition of different fatty acid glycerides in oils of different climatic regions. The test is useful only when groundnut oil is the only adulterant in sesame oil. As regards other oils further work is under progress.

Public Health Laboratory, C. M. DESAI.
Borough Municipality, A. H. PATEL.
Surat,
December 6, 1944.

INVESTIGATION OF NEW PLANT-LARVICIDES WITH SPECIAL REFERENCE TO *SPILANTHES ACMELLA*

MALARIA-CONTROL in India as elsewhere consists essentially in the elimination of the malaria-carrier anopheline mosquito, which is achieved with comparatively more ease and success by destroying it in its larval stage with the use of larvicides. The only effective mosquito-larvicidal plant, apart from synthetic larvicides, known and used uptil now is *Crysanthemum cinerarifolium*, popularly known as pyrethrum. We undertook to investigate the mosquito-larvicidal properties of some select plants which are popularly known to possess some insecticidal properties.

To start with, water and alcoholic extracts of the different parts of the plants were tried to see their effect on anopheline larvæ. If promising results were obtained, the plant was subjected to a detailed examination. The following plants were investigated:—

(1) Berries of *Duranta plumieri* (N.O. verbenaceæ).
(2) Leaves and stems of *Ipomœa murioata* (N.O. Convolvulaceæ).
(3) Stems of *Berberis aristata* (N.O. Berberidaceæ).

(4) Stems of *Acorus calamus* (N.O. Araceæ).
(5) Leaves and stems of *Aristolochia bracteata* (N.O. Aristolochiaceæ).
(6) Seeds of *Butea frondosa* (N.O. Papilionaceæ).
(7) Flowers and leaves of *Spilanthus acmella* (N.O. Compositæ).

The first four plants had either no lethal effect or were feeble in action. Durranta is a commonly used hedge-plant and Dr. Manson[1] suggested that the alkaloid in the berries was possibly the toxic factor. We have extracted the alkaloid and found it to be possessing a negligible toxicity.

Aristolochia bracteata and *Butea frondosa* showed a fairly good action. The preliminary trials with alcoholic and water extracts of *Butea frondosa* having proved rather encouraging the petrol extract was tried and was found to be effective in a concentration of 1 per cent. in water.

Spilanthes acmella.—The fresh flowering tops of this plant were extracted with ether. The ether extract was yellowish in colour and produced a highly tingling sensation on the tongue. The extract is insoluble in water but is easily soluble in boiling alcohol, cold benzene or solvent naphtha. The larvicidal property of the extract was studied quantitatively as follows: 100 mgs. of the extract was dissolved in 5 c.c. of alcohol with 100 mgs. of pure castile soap and this solution was poured into one litre of water with shaking. The suspension of the extract thus formed, was stable enough for the work. This suspension was diluted with the required quantities of water to give the different concentrations used in the experiments. Controls, containing equivalent quantities of alcohol and soap in the same concentrations used, were also kept. These controls did not show any effect on the larvæ over 24 hours of observation. These suspensions and controls were kept in beakers and 10 anopheline larvæ were kept in each. All the larvæ used in the experiment were fresh, obtained from the same habitat and were of the third or the fourth stage. The larvæ in suspensions of the material, first showed a stage of irritation with brisk movements, later on lost their activity and were unable to reach the surface. The time was noted when all the larvæ lost their capacity to reach the surface and is indicated in the following table under the heading as "The time required for the loss of capacity to float". The time taken by all the larvæ for complete death is also noted and is given in the table. These experiments were repeated several times with closely similar results. It is evident from these experiments that the extract of *Spilanthes acmella* is lethal to anopheline larvæ even in a dilution of 1 in 100,000.

TABLE I

Concentration	Time required for the loss of capacity to float	Time required for death
1 part in 10,000 of water	5 minutes	40 minutes
1 „ „ 25,000 „	15 „	120 „
1 „ „ 50,000 „	25 „	180 „
1 „ „ 100,000 „	35 „	15 hrs.

Chemical investigation of this plant is in progress and spilanthol[2] has been isolated and identified in the ether extract. Spilanthol was isolated earlier by Japanese workers from *Spilanthes oleracea* or American para-cress. The ether extract on treatment with 60 per cent. alcohol precipitates a large amount of waxes and sterols which have no action on larvæ and also have no tingling taste. The alcohol-soluble material has a tingling taste and about two-thirds of it is spilanthol, which appears to be the main active constituent.

A patent regarding the use of this extract as larvicide has been applied for.

We take this opportunity to express our heartfelt thanks for the supply of flowers to Prof. L. S. S. Kumar, Economic Botanist to the Government of Bombay, without whose help and co-operation it would have been impossible to carry out this work.

Further work is in progress.

G. S. PENDSE.
N. L. PHALNIKAR.
B. V. BHIDE.

Maharaja Pratapsinh Chemical Lab.,
Sir Parashurambhau College, Poona,
and
Indian Drugs Res. Assn., Poona,
December 6, 1944.

1. Manson, *J. Inst. Malaria* (Delhi), 1939, **2**, No. 1, 85. 2. Gerber, F., *Arch. Pharm.*, 1903, **241**, 270. Y. Asahina and M. Asano, *J. Pharm. Soc.* (Japan), 1920, 503. —, *Ibid*, 1922, 85. M. Asano and T. Kumematsu, *Ber.*, 1932, **65B**, 1602.

ACTIVITY OF SULPHANILYL-BENZAMIDE AGAINST TYPE I PNEUMOCOCCAL INFECTION IN MICE

(A Preliminary Note)

IN a previous paper (Bose and Ghosh, 1944) it has been noted that after oral administration in mice, sulphanilyl-benzamide gave rise to a fairly high blood concentration with low percentage of conjugation, and maintained a more steadier level than sulphanilamide. Further work on its urinary excretion (Bose and Ghosh, 1944) in human volunteers, has also shown it to be rapidly eliminated through the system. Brownlee and Tonkin (1943) have already observed its bacteriostatic effects *in vitro* against the intestinal pathogens. Considering its high systemic absorption and rapid urinary excretion, it was considered to be of interest to study its effect against certain coccal infections of the body. The present paper deals with the result of treatment by sulphanilyl-benzamide against Type I pneumococcal infection in mice.

EXPERIMENTAL

The technique employed in assessing the therapeutic activity of the drug was essentially the same as described by Bose *et al.* (1941) in a similar paper on sulphamethylthiazole. The drug was fed to mice in a 5 per cent. aqueous solution of pH ca 8·2. The animals used weighed 20 to 22 gms. The activity of the drug was compared simultaneously with that of 2-(*p*-amino-benzene sulphonamido)-pyridine, which was taken as a standard. Two

Effect of treatment of sulphanilyl-benzamide and sulphapyridine on mice (average weight 20 gms.) infected with pneumococcus Type I

Infecting dose = 0·2 c.c. of 10^{-6} dilution of an 18-hour serum broth culture.
Number of mice in each group = 20.

Days of observation after infection	Group A, control		Group B, Sulphapyridine			Group C, Sulphanilyl benzamide			Group D, Sulphanilyl-benzamide		
	Dead	Survived	Daily dose fed	Dead	Survived	Daily dose fed	Dead	Survived	Daily dose fed	Dead	Survived
1	0	20	20 mg.	0	20	20 mg.	0	20	30 mg.	0	20
2	10	10	20 ,,	0	20	20 ,,	0	20	30 ,,	0	20
3	14	6	20 ,,	1	19	20 ,,	6	14	30 ,,	6	14
4	6	0	20 ,,	6	14	20 ,,	18	2	30 ,,	6	14
5				6	14		19	1		10	10
6				7	13		20	—		16	4
7				9	11					17	3
8				11	9					17	3
Average survival days (max. 8)	1·8		6·0			2·85			4·4		

sets of doses, once daily, were employed in the case of sulphanilyl-benzamide and a single set in case of sulphapyridine. The drug given at each administration and the number of animals used with each dose are stated in their respective protocols.

The organism for producing the infection was a strain of Type 1 pneumococcus, the virulence of which was maintained by repeated passage in mice. Previous to experiment, the virulence of the strain was so much enhanced that 0·2 c.c. of a 10^{-9} dilution was sufficient to kill the animals in 48 hours. This was taken to be the minimum lethal dose. The dose used for infecting the animals was 0·2 c.c. of 10^{-6} dilution of an 18-hour serum broth culture, which contained about 1,000 M.L.D.s. The animals were injected intraperitoneally with the infecting dose half an hour before commencing the treatment. The observation was continued for a period of eight days, and the animals, dying on a day, were all subjected to post-mortem examinations. Cultures of heart blood in all these animals were positive for pneumococci. The average survival time as given in the table, was calculated by totalling the number of days survived by each mouse and then dividing by the number of animals used in each investigation according to the procedure followed by Whitby (1937).

Discussion and Conclusion

From a statistical analysis of the average survival time and the mortality rates (*vide* Table) it is evident that the lower dosage of sulphanilyl-benzamide does not give any significant protection to mice infected with a highly virulent strain of pneumococcus Type I. But, on the other hand, it is being found that the difference between the survival time of mice treated with the higher dosage (30 mgs. daily) and that of the untreated controls is certainly significant. This is also apparent from the fact that a certain number of mice were fully protected up to the period of observation with this dose, while there were none with the lower one. Of course, the drug is far behind in activity when compared with sulphapyridine, where a higher rate of average survival time and a larger number of fully protected animals are found. It can, thus, be concluded that contrary to sulphanilamide which has no protective action against Type I pneumococcus, sulphanilyl benzamide possesses a definite anti-pneumococcal activity, though inferior to sulphapyridine.

It remains, however, to be seen whether this widening of activity possessed by this substituted sulphanilamide derivative is in any way directly related to the substitution of So_2NH_2 radicle; or whether the breaking up of the substituted molecule inside the body into *p*-amino-benzene-sulphonamide would be the cause of such activity.

Summary

1. Sulphanilyl-benzamide, when administered in higher dosage (30 mgs. daily for four days) to mice, infected with pneumococcus Type I, possesses a definite anti-pneumococcal activity as shown by an increase in survival period and a certain percentage of fully protected animals.

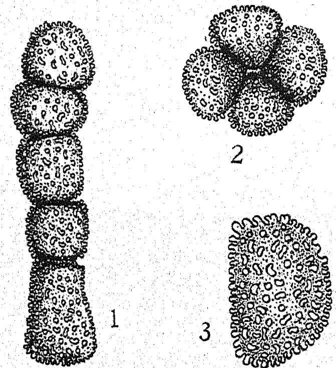
2. The activity of the drug, in comparison with sulphapyridine, however, is less.

Bengal Immunity Research Lab.,
Calcutta, A. N. Bose.
December 8, 1944. J. K. Ghosh.

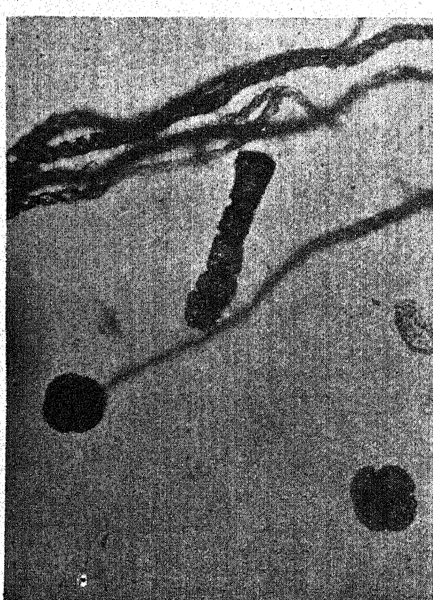
Bose, A. N., and Ghosh, J. K., *Curr. Sci.*, **1944, 13,** 230-31. —, —, *Ind. J. Med. Res.*, 1944, **32, 61.** —, Das Gupta, S. J., and Basu, U. P., *Ibid.*, **1941, 29, 265.** Brownlee and Tonkin, *Nature*, **1941, 148, 167.** Whitby, L. E. H., *Lancet*, **1937, 1, 1517.**

ON SOME PECULIAR SPORES IN *DUMORTIERA HIRSUTA* REINW. BL. et NEES

WHILE examining the teased material of a sporogonium of *Dumortiera hirsuta* from Kodaikanal on the Pulneys, the author found among the normal spore-tetrads a group of five spores attached end to end in a row (Text-Figs. 1 and 4). These spores were quite mature and had a thick brown wall with the characteristic sculpturing of the normal spore. Of the five spores, one was very large—about twice the size of the remaining ones. This large spore when focussed to its centre, showed a very faint transverse line, as if the protoplast had just begun to divide but the further progress of its division was arrested due to some cause.



Text-Fig. 1. Abnormal " spores," × 560.
Text-Fig. 2. Normal spore-tetrad, × 560.
Text-Fig. 3. A single ripe spore, × 680.



Text-Fig. 4. Photomicrograph showing the abnormal " spores " and normal spore-tetrads and elaters, × 320.

The exact significance of this row of five spores is not clear. At first sight, it looked as though the spore-mother-cell had formed a linear tetrad instead of the usual tetrad. But the presence of the fifth cell makes this explanation untenable. The course of development of the spores in *Dumortiera* is as follows. After the sporogenous tissue is differentiated in the sporogonium, the sporogenous cells become very much elongated. Of these some divide by transverse walls into a row of cells which by further enlargement become the spore-mother-cells, while the remaining cells do not divide, but develop into elaters. These spore-mother-cells ultimately separate from one another and form the tetrads of spores. The row of five spores referred to above would appear to represent a row of spore-mother-cells formed by one of the original elongated sporogenous cells. These five spore-mother-cells, unlike the normal spore-mother-cells, have failed to enlarge and divide into tetrads of spores, but have remained still attached to one another in a row. Further development of these five spore-mother-cells was evidently arrested owing to some cause. These spore-mother-cells have, therefore, not advanced very much from their early condition and so remained undivided and became transformed into spore-like structures.

The question whether these five cells in a row are really spore-mother-cells or not can be decided definitely only by a cytological examination of the plants developed from these spores. The plants formed from them would be diploid. Unfortunately no more spores of this kind could be found for deciding this point, though a large number of sporogonia from living material was examined.

No record of such rows of "spores" appears to have been made before in *Dumortiera hirsuta*, or in any of the other members of the Marchantiales. It may be mentioned, however, that Hofmeister (1862, Pl. VI, Fig. 23) has recorded in *Blasia pusilla* a case of two spore-mother-cells being held together. But each of these two spore-mother-cells, unlike in the present case, had already divided and formed a tetrad of spores.

It is my pleasant duty to record here my thanks to Prof. M. O. P. Iyengar for his kind suggestions and criticisms.

Department of Botany,
University of Madras, K. S. SRINIVASAN.
December 10, 1944.

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EASTERN LIMIT OF THE 1943 SWARMING OF THE DESERT LOCUST, *SCHISTOCERCA GREGARIA* (FORSKAL), IN INDIA*

PRUTHI[1] (1944) has stated Patna (lat. 25° 41′ N., long. 85° 17′ E.) in Bihar as the most eastern Indian limit reached by Desert Locust swarms in 1943.

Several months ago Mr. J. C. Mukerji, of Khardah, 24-Parganas, Bengal, brought to me a male specimen of the Desert Locust that he had collected on June 25, 1943, from a swarm at Deogarh (lat. 24° 30′ N., long. 86° 42′ E., Santal Parganas, Bihar), where the swarm was observed on two days (June 24 and 25, 1943), passing from the S.W. to the N.E. without stopping at Deogarh. Mr. Mukerji's specimen was one of the few stray individuals which, however, did alight. It has been deposited in the Zoological Survey of India (Reg. No. 1231/H5), and is a typical yellowish *Phasis gregaria* male of *Schistocerca gregaria*. The above swarm has also been independently confirmed by the Subdivisional Officer of Deogarh.

The Deogarh record extends the Patna limit by about ninety miles farther east.

Mr. D. R. Bhatia (New Delhi) recently informed me that since the publication of Pruthi's note, he had information of the 1943 swarms reaching Pothia area (lat. 25° 33′ N., long. 87° 15′ E., Bhagalpur District, Bihar), which means that the Deogarh limit is extended by some thirty miles to the east. Deogarh, however, remains the most southern point of the eastern limit reached by the Desert Locust in 1943.

Zoological Survey of India, M. L. ROONWAL.
December 18, 1944.

* Published with the permission of the Director, Zoological Survey of India.

1. Pruthi, H. S., *Curr. Sci.*, 1944, **13**, 174.

LARGE-SCALE APPLICATION OF MERCURY FOR PREVENTION OF INSECT PESTS IN STORED FOOD GRAINS

IT was pointed out by the author[1] that since mercury vapour is the active reagent in sterilising insect eggs and killing small larvæ, a very small quantity of mercury is necessary for preservation of grain. Vapour pressures of mercury at ordinary temperatures are very small and the quantity required to saturate a particular space with mercury vapour is also very small; *e.g.*, 12 mgms. of mercury per cu. metre) is the equilibrium concentration at 25° C., and 40 mgms. at 35° C. It was also pointed out that since vapour pressure of mercury is a function of temperature, the point of prime importance is the rapid attainment of the equilibrium concentration of mercury vapour at that temperature in the space in which the grain is stored. A simple way of facilitating this process is to disperse the mercury so as to expose as large a surface as possible for its evaporation. This was achieved by spreading mercury between ribbons of porous paper or converting it into very fine dust. After making sufficient allowance for the loss of mercury by diffusion it was expected that about one gram of mercury per bag of 240 lbs. of grain would suffice to preserve it from insect attack for about one year (Dole, *loc. cit.*).

It was also pointed out[2] that mercury vapour is acting as a fumigant and not as a contact or stomach poison, so all means to conserve the mercury vapour would prove effective against breeding of insects.

These expectations were fulfilled in small-scale experiments and, therefore, they were tried on a large-scale at Kirloskarwadi (Dist. Satara, Bombay Presidency) in the godown owned by Messrs. Kirloskar Brothers, Ltd. In all 408 bags of different grains were treated with the dust and stored for a period of five months, *i.e.*, from the end of June to the beginning of December 1944. The preserved bags consisted of the following grains:—

Jowar 216 bags, gram 92 bags, wheat 50 bags, tur dal 50 bags. Each bag weighed about 200 to 225 lbs. They were stored in a godown of 65 ft. × 30 ft. ×15 ft. and besides the above bags there were about 1,500 bags of untreated and infested grain. Treated bags were kept separate and an equal number or more of untreated bags were kept as control (with the exception of wheat) not very far off from the treated bags. The bags were arranged so as to conserve the mercury vapour as far as possible. The bags in the centre of the stack were treated with 1 gm. of mercury and the outer ones were treated with 5 gms. of it. At the end of five months the bags were examined and the samples from different bags were collected and studied.

Following is the summary of the mean of the various counts of the damaged grains:—

Name of the grain	Original condition	Condition after treatment of 5 months	Condition of the untreated grain after 5 months
Gram	Some eggs seen on the grain	Not a single grain bored	Cent per cent. grain holed, some with 2 or 3 holes
Jowar	Slightly infested	3 % grain affected	34 % grains holed with some powder formed
Wheat	Not infected	Not a single grain affected	———
Tur dal	,, ,,	,, ,,	Slight damage seen, some powder formed

The gram was infested with eggs of *Bruchus Chinesis* and jowar was infested by *Calandra oryzœ*, *Rhizopertha dominica* and *Triboleum casteneum*.

The experiment speaks for itself. If it is taken into consideration that the experimental grain was stored along with a large quantity of infested grain in the godown the results are excellent. The grain was stored in the months of July to November, a season which is most favourable for the activities and the breeding of many of the insects affecting the stored grains. The infested grain existing in the godown was seen to be containing the *Calandra oryzæ, Triboleum castaneum, Rhizopertha dominica, Sitotroga cereallela* and *Bruchus Chinesis.*

It should be noted that mercry is effective mainly towards sterilization of eggs and killing of small larvæ and is not so effective against adult insects, say *e.g.*, the *Sitophylus oryzæ*. So the method will prove more useful with uninfested grain or grain infested with insects which, in adult stage, do not cause much damage. If the grain is slightly infested the breeding of the insects is stopped, but if it is badly infested especially with a pest whose adults cause much damage then it is desirable to supplement the mercury by some method for elimination of these insects; either by killing, repelling or by removal by sieving. In a recent work in this laboratory the mercury method is supplemented by a substance with insect-repelling properties. The account of this insect-repellant will be published in due course.

I must thank Messrs. Kirloskar Brothers, Ltd., for placing at my disposal grain worth more than Rs. 10,000 and giving me facilities to carry out this large-scale experiment at their own cost.

Fergusson College,
Poona, K. K. DOLE.
December 12, 1944.

1. Dole, *J. University of Bombay*, 1943, **11**, Part 5, 118. 2. Dole, K. K., *Proc. Ind. Sci. Cong. Agric. Sec.*, Jan. 1944.

LIFE-HISTORY OF AN ECTOPARASITIC BRACONID ON A PSYLLID, *PAUROPSYLLA DEPRESSA* (CRAW)

WHILE I was working on *Pauropsylla depressa* (Craw), a gall-forming Psyllid, I found the larva of a Braconid parasite leading an ectoparasitic life. The life-history of the ectoparasitic Hymenoptera is very interesting and worth recording.

Pauropsylla depressa (Craw) attacks the leaves of *Ficus glomerata* Roxb., and gives rise to large, globose galls. Galls are simple and unilocular, sometimes several simple galls fuse incompletely and form into a compound mass. The Psyllid spends all the developmental stages within the gall. After reaching adult stage it comes out of the gall through the lacerated opening which is formed on the lower side of the leaf.

The eggs are laid by the Braconid parasite in batches of six to nine near the gall on the upper surface of the leaf. The eggs are white in colour and cylindrical in form. Each egg measures about a millimetre in length and 0·4 millimetre in breadth.

The larvæ of the parasite hatch out of the eggs after some days and enter the gall cavity by boring the tissue of the gall which is thick and soft. The larva is almost white in colour, cylindrical in shape and both anterior and posterior regions are somewhat pointed. There are thirteen segments of approximately equal length. The mandibles are almost invisible. Fine setæ are present on the dorsal region.

It is remarkable to note that only a single larva enters a single gall. The Braconid parasite attacks the host, *Pauropsylla depressa* (Craw), usually in the second instar. The Braconid larva after entering the gall cavity migrates towards the host and reaches its dorsal region. Then the parasitic larva proceeds to one of the sides of the host and attaches itself by the mouth on the ventral side to the intersegmental region of the last thoracic and first abdominal segments, as shown in Fig. 1. From this time onwards the parasite leads an ectoparasitic life on the Psyllid. After a few days a tube-like organ appears as shown in Fig. 2 which may be called a tube of attachment. This tube is very thin and measures about 0·7 mm. in length. The origin and function of this tube is not fully known. After the development of the tube of attachment the host becomes inactive and after a few days the host is killed. After the death of the host the parasite detaches itself from the host and enters into the pupal stage. The fully grown parasitic larva measures 1·8 mm. in length and 0·7 mm. in breadth.

The parasitic larva slowly migrates to a corner in the gall cavity and covers itself by a white parchment and remains within it for the rest of the pupal stage. As the growth takes place in the parasite the parchment-like covering enlarges in size and occupies nearly the whole cavity of the gall made by the Psyllid. After the completion of the pupal stage the adult Braconid emerges out of the gall through a lacerated opening which is formed as the gall gets dry.

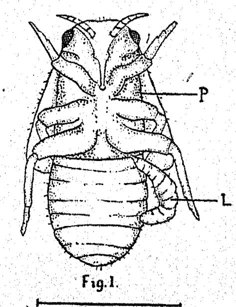

FIG. 1. Ventral view of the Psyllid showing the attachment of the Braconid larva.
L – Braconid larva.
P—Psyllid.

The adult Braconid measures 2·1 mm. in length. The colour of the body is brownish-red. The percentage of attack is about 85. It

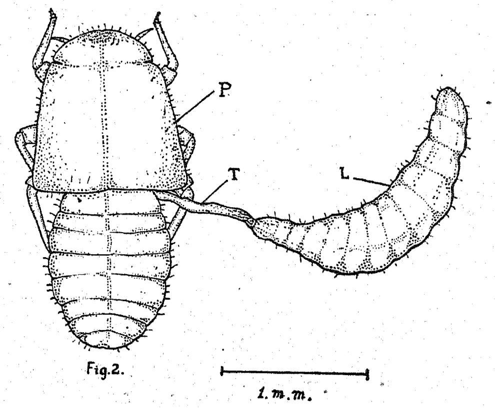

FIG. 2. Dorsal view of the Psyllid showing the tube of attachment.

P—Psyllid.

T—Tube of attachment.

L—Braconid larva.

has been observed that the attack of the Braconid parasite is more in some localities while in some cases the host *Pauropsylla depressa* (Craw) is free from the attack.

I am highly thankful to the Vice-Chancellor of the Osmania University for permitting me to work in Dr. S. Mehdi Hassan's Laboratory; and to Prof. B. K. Das, Chairman, Zoology Department, for his encouragement and active interest.

(The adult Braconid has been sent to a specialist for identification.)

Hyderabad (Dn.), MOHAN BABU NAIDU.
December 23, 1944.

NATURE OF OESTROGENIC SUBSTANCE IN THE OVARY

THE ability of œstrogens to induce lipemia has already been demonstrated[1,2,3] This activity appears to be related to fat metabolism. It was, therefore, of interest to find out whether œstrogenic substance of the ovary is in any way connected with lypolytic enzymes. Preliminary observations show that a part of the œstrogenic substance of ovary is (1) precipitable by ammonium sulphate, (2) non-dialysable and (3) associated with a lypolytic enzyme.

The distribution of the œstrogen and lipase in the various fractions was examined. The ovaries were extracted with 10 per cent. NaCl solution for 15 to 20 hours at low temperature. The clear (tissue-free) extract which is obtained by filtration through a Buchner, was saturated with ammonium sulphate, the precipitate taken up in distilled water and dialysed in cold in colloidon bags. The dialysate is then filtered. The estimation of œstrogens in the different fractions is carried out by the modified photometric method.[4,5] Lipase activity was determined by its action on olive oil substrate. The results are tabulated below.

Expt.	Original 10% salin extract	Ammn. sulphate precipitated and dialysed extract	corrected results of the dialysed extract.
Oestrogens 1. Free	0·12	0·00	0·00
Oestrogens 2. Total	0·37	0·20	0·25
Oestrogens 3. Combined	0·25	0·20	0·25
Dry wt. of 5 cc. of extract	0·3557 gms.	0·0266 gms.	0·032 gms.
Lipase activity of 5·0 c.c. of extract. cc. of N/20 alkalie.	1·27 c.c.	1·31 c.c.	1·63 c.c.

An aliquote of 40 c.c. of the original 10 per cent. saline solution was subjected to ammonium sulphate saturation and subsequent redissolution of the precipitate formed and dialysis. The final volume of the dialysate was 50·0 c.c. Hence a correction has to be applied to all the results of the dialysed fraction. Column III in the table gives the corrected results.

The results show that a part of the œstrogens is in the combined form, which is precipitable by ammonium sulphate. The results also reveal that the lipase activity of the dialysed extract is apparently enhanced; this might be due to the removal of inhibiting substances which are likely to be present in the original 10 per cent. saline extract. Hence the parallelism between the œstrogen and lipase could not be established.

Thanks are due to Prof. V. Subrahmanyan and Dr. N. N. De for their keen interest.

Department of Biochemistry,
Indian Institute of Science,
Bangalore, M. B. SAHASRABUDHE.
December 8, 1944.

1. Lorentz, Chaikoff, Entermann, *J. Biol. Chem.*, 1938, **126,** 763. 2. Loeb, H. G., *Proc. Soc. Expt. Biol. Med.*, 1942, **49,** 340. 3. Zondek, B., "Genil l Functions and their Hormone regulation," 1941. 4. Bachmann, C., *J. Biol. Chem.*, 1939, **131,** 455. 5. —, *Ibid.*, 1941, **138,** 700.

THE EFFECT OF ELECTRIC FIELD ON THE DEPOLARISATION OF LIGHT SCATTERING IN COLLOIDAL SYSTEMS

THE influence of the magnetic field on the depolarisation of the Tyndall scattering in graphite sols, has been investigated in detail by Krishnan,[1] using both polarised and unpolarised incident beams. Krishnan has attributed the changes in the depolarisation values to the orientation of colloidal particles. Hoover,[2] on the other hand, has tried the orientating influence of electric field on bentonite sols but he does not notice any change in the depolarisation factor when the field is applied. Recently Subramhanya and others[3] employed graphite and stearic acid sols to study the effect of electric field on Tyndall scattering using polarised incident beam. The study of the Tyndall

scattering by these authors has been qualitative in nature as they merely find out whether the scattered light increases or diminishes in intensity. In the present investigation a quantitative study of the degree of depolarisation is taken up. In view of the fact that both bentonite and graphite sols consist of laminar particles, the effect of electric field on the depolarisation of Tyndall scattering in graphite sols has been studied using incident beam (1) unpolarised, (2) polarised with vibrations perpendicular to the plane containing the incident and scattered beams and (3) polarised with vibrations parallel to this plane. The depolarisation factors for these incident beams (ρ_u, ρ_v and ρ_h) have been measured with the electric field (1) perpendicular to the incident beam and the direction of observation, (2) parallel to the direction of observation and (3) parallel to the direction of the incident beam.

In general the value of the depolarisation factor depends upon (1) the direction of the electric field, (2) on the potential gradient of the applied field and also on (3) the nature of the incident vibrations. The effect of alternating electric field is also investigated. It is noticed that within the limits of experimental errors, both direct and the alternating electric fields give the same values for the depolarisation factor.

In the investigations carried out, only alternating current is employed as it avoids the gas formation and unnecessary disturbance of the liquid. The following tables indicate the variation of depolarisation with the application of the electric field.

TABLE I

Electric field perpendicular to the incident beam and the direction of observation. Alternating circuit of 60 cycles employed.

Applied electric field volts per cm.	ρ_u%	ρ_v%	ρ_h%
0	33·1	7·0	23·6
40	34·4	5·2	18·9
60	34·2	4·6	14·4
80	34·7	4·3	12·8
120	35·5	3·9	11·5
180	36·4	3·6	10·4
300	36·7	3·2	10·3

TABLE II

Electric field perpendicular to the incident beam and parallel to the direction of observation.

Applied electric field volts per cm.	ρ_u%	ρ_v%	ρ_h%
0	33·1	7.0	23·6
60	33·1	7·8	25·5
120	32·8	9·1	30·7
180	31·5	10·8	35·0

TABLE III

Electric field parallel to the incident beam and perpendicular to the direction of observation.

Applied electric field volts per cm.	ρ_u%	ρ_v%	ρ_h%
0	33·1	7·0	23·6
60	31·2	7·3	29·0
120	30·5	7·9	39·4
180	29·5	8·3	44·8

It is of interest to note that although electric field has no influence on the depolarisation with bentonite sols, yet with the graphite sols, large variations are observed. The results obtained with the electric field are in general in agreement with those obtained by Krishnan,[1] with the magnetic field. The influence of the electric field on the variation of depolarisation factor in vanadium pentoxide, benzopurpurin, and stearic acid sols is under investigation. The details will be published later.

Dept. of Pure & Applied Chemistry,
Indian Institute of Science,
Bangalore, M. R. ASWATHA NARAYANA RAO.
December 23, 1944.

1. Krishnan, R. S., *Proc. Ind. Acad. Sci.* (A), 1938, **1**, 91. 2. Hoover, *J. Phy. Chem.*, **1942**, **46**, **81**. **3.** Subramhaya, Doss and Rao, *Proc. Ind. Acad. Sci.* (A), 1944, **19**, 405.

POTATO SEEDS FROM "CHIPS"

THE interesting note in the December 1944 *Current Science* of Pal and Deshmukh[1] on "Potato 'Tops' and 'Eyes' as Seed", confirming the earlier findings of Cleland[2] at Belfast and of Evans[3] at Kew, has just come to our notice. Experimental work on the possibilities of utilising thin slices of potato tubers containing 'eyes'—"chips" as Evans calls them—has been in progress in this Laboratory since August 1943. Though we have been able to obtain by closer sowing of 'chips' an yield similar to that obtained from 'normal' (half-tuber) seeds, the publication of our data was withheld pending the results of the following necessary experiments we have planned to carry out this year, to find: (1) the comparative yield from normal and chips when grown in water culture solution in which most of the complications due to soil variation are eliminated, (2) large-scale field sowing of differing sprout lengths of chips with different spacings of both normal and chip seed material at the newly acquired U.P. Government Farm at Hawalbagh, (3) the effect of storage under different environmental conditions on the viability of the chips.

The following summary, however, of the

results of our several exploratory experiments is likely to interest the workers in this line of research.

In all our experiments, 'Majestic' variety of potato obtained from the U.P. Agricultural Department was used, except in the last experiment, for which the small Patna variety of potato obtained from the local bazaar was used. Sowings were done directly in randomised field plots. A minimum of four replications was used in all experiments. Tubers cut into halves and the slices of tubers with eyes were stored at room temperature for 24 hours and sown the next day. For each experiment, except the first, the weights of the normal and chip seed material used were recorded. The subsequent percentage germination of the different seed materials and the general nature of the vegetative growth were noted.

Experiment I.—Sown on August 28, 1943, and harvested on December 11, 1943. The eyes were just sprouting in the tubers used for this experiment. Very thin slices—2 to 3 mm. in thickness at the base of the 'eyes'—were taken both from the rose-end as well as from the sides of the tubers. Similar spacing, 30″× 18″, was used both for the normals and the chips and ninety seeds of each variety were sown. Germination of the normals was 94 per cent. and of the chips, 70 per cent. The vegetative growth was distinctly poor in plants from chips, but they produced tubers of similar sizes, though the calculated yield per hundred plants from the normal seeds was 42 lb. 1·4 oz., while from chips, it was 15 lb. 1·3 oz. The observed lower germination of and diminished yield from chips are statistically significant.

Experiment 2.—On account of the very unsatisfactory germination percentage of very thin chips used in the previous experiment, thicker slices—4 to 5 mm.—of the tubers were used for chips and they were all taken from the rose-end. Thirty-two seed materials each of normal and chips were sown on December 21, 1943, and harvested on May 24, 1944. The average weight of the normal seeds used was 36·0 gm., while that of the chops was 6·3 gms. In this off-season sowing the final stand of plants from both normal and chip seeds was poor but similar, amounting to about 72 per cent. No striking difference in the vegetative growth was noticed, since variation from plant to plant was marked alike in normal and chip rows, but the calculated yield per 100 plants from normal seeds was 59 lbs. 12·6 ozs. and from chips, 24 lbs. 7·3 ozs. The observed difference is statistically significant.

Experiments 1 and 2 corroborate the findings of the earlier workers mentioned above, that the yield from normal tubers under similar spacings is greater than that from chips, and that when very thin slices, "peelings", are used the germination is lower than in the controls.

Experiment 3.—This experiment was undertaken to find out the germination of chips taken from rose-end and from sides, as compared to the normals. Forty seed materials used per treatment were sown on March 8, 1944. The observed germination of the normal seeds was 95 per cent. of the chips taken from the rose-end, 100 per cent. and of the chips from sides, 85 per cent. The observed difference in the germination of the chips from rose-ends and from the sides is statistically significant at 5 per cent. level.

Experiment 4.—This experiment was undertaken to observe the comparative yield of chips taken from tubers with eyes at two different stages of sprouting. Rose-end of tubers with sprouts, (*a*) 10 to 12 mm. long and (*b*) 3 to 5 mm. long, were used for chips and were sown along with their corresponding normal seeds on March 19, 1944. There were thus four treatments: A-normal, A-chips, B-normal and B-chips. Forty seed materials were used for each treatment. All the seeds germinated except one in B-normal. The tuber material saved by the use of rose-end chips varied from 94 to 88 per cent. The experimental plants were badly damaged by monkeys but unfortunately the damage was not randomised and, therefore, the observed yield, when the tubers were lifted on August 5, 1944, from A-normal, 14 lbs., from A-chips, 16 lbs. 2 ozs., from B-normal, 13 lbs. 8 ozs. and from B-chips, 4 lbs. 2 ozs. cannot be considered as reliable data. But from the trend of the yield and the observed nature of the vegetative growth of the plants the conclusion seems justified that chips with sprouts 10 to 15 mm. long are likely to give better yield than chips with 3 to 5 mm. sprouts.

Experiments 3 and 4 will be repeated to observe the comparative germination and yield using chips from unsprouted tubers, tubers with sprouts 3 to 4 mm., and 10 to 15 mm. long, along with their corresponding controls.

Experiment 5.—This experiment was designed to find out whether yield similar to the normal can be obtained by using rose-end chips with 10 to 15 mm. long sprouts with closer spacing. The number of normal seeds used in this experiment was 64, and of chips, 128. These were sown on July 6, 1944, and harvested on October 17, 1944. The distance between all rows was 24″ and between seeds 18 inches in normal and 9 inches in chips. The germination in case of normal seeds was 78·1 per cent., and in the case of chips, 79·7 per cent. The difference is not significant. The average weight of a normal seed was 47·23 grams and of a chip, 3·45 gm. The total weight of the 64 normal seeds used in this experiment was 109·75 ozs. and of 128 chips, 15·6 ozs. The final stand of the normal plants was 46, and of the chip plants, 89. The total yield (excluding the border plants) from 46 normal plants was 43 lbs., while from 89 chip plants it was 50 lbs. and 10 ozs. The observed increased yield from chips, however, is not statistically significant.

Experiment 6.—In this experiment another variety of potato was used—the small round Patna variety obtained from the local Almora bazaar. The sprout lengths of the tubers varied from 6 to 10 mm. The spacing used for chips in this experiment was slightly increased from one-half (used for Experiments 5) to two-thirds, being 24″ × 12″ for normal seeds

and 24" × 8" for the rose-end chips. The weights of the 40 normal and 60 chip seeds sown on August 7, 1944, were 11·6 ozs. and 4·56 ozs. respectively. The germination of the normal seeds was 90 per cent. and of the chips, 96 per cent. The difference is not statistically significant. The nature of the vegetative growth of the plants from normal and chip seeds was similar. The tubers were lifted on December 26, 1944, and the yield obtained from 37 surviving normal plants was 14 lbs. 14 ozs., and from 57 chip plants, 13 lbs. 15 ozs. The difference in yield observed is not statistically significant.

The results of Experiments 5 and 6 indicate that yield similar to that obtained from normal seeds of 'Majestic' and Patna variety of potatoes can be obtained under similar cultural conditions when rose-end chips are used for seeds but sown with closer spacings. The average saving of potato tuber material when chips are used for seed purposes is very appreciable, being 85 to 88 per cent. in case of 'Majestic' and about 60 per cent. in case of small Patna variety. The utilisation of the tuber material saved can best be achieved by the setting up of dehydration plants or industrial units in the potato-growing areas.

The expenses of this investigation have been met from a grant received from the Department of Agriculture, U.P., Lucknow.

Vivekananda Laboratory,
Almora, U.P.,
January 8, 1945.

B. SEN.
S. C. CHAKRAVARTI.

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LIESEGANG PHENOMENON IN RUBBER LATEX

A NEW case of Liesegang rings formation has been observed during coagulation of rubber latex in our investigation of the properties of rubber latex.

Rubber latex (ammonia-preserved) having a dry rubber content of about 30 per cent., and an ammonia content of about 0·5 per cent., was spread as a thin film on a glass plate. One drop of zinc chloride solution (15 per cent.) was placed at the centre of the film, and the plate was then kept covered. After some time (about 10 to 12 hours) the development of characteristic concentric rings was observed. With stronger solutions of zinc chloride a multitude of microscopic rings, very closely spaced, was observed. This is analogous to the 'Secondary rings' reported by Möeller[1] and also by Schleussner.[2] Other salt solutions such as zinc sulphate, magnesium chloride, magnesium sulphate, cadmium chloride and barium chloride were also found to give similar ring systems.

The same type of periodic phenomenon was observed when a narrow glass tube containing rubber latex was kept dipping in a solution of any of the above-mentioned salts. In these experiments definite bands of precipitate were not formed, but the coagulum consisted of an undulatory filament of a 'crimped' structure. The distance between successive peaks of the "wave" could easily be measured by means of a cathetometer. This observation is analogous to the results obtained by Hedges[3] in his experiments on periodic structures caused by coagulation of arsenious sulphide sol by ferric chloride in the absence of any gel medium.

Further work in this line is in progress.

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January 30, 1945.

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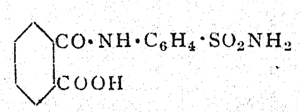
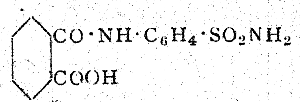
A SIMPLE METHOD OF PREPARATION OF N⁴-SUBSTITUTED DISULPHANILAMIDO-DERIVATIVES OF SOME DIBASIC ACIDS

N^4-ACYL derivatives of sulphanilamide derived from dibasic acids have recently been prepared by a few workers by indirect methods[1,2,3,4] and in a few cases by the reaction of the appropriate dibasic acid,[5] the ester,[5] acid chloride,[4,5,6,7] anhydride[8,9] or amide[4] with sulphanilamide. Excepting the work of Bergmann and Haskelberg[7] there is no mention in the previous work of the formation of any disulphanilamido derivatives.

There appeared to be no reason, however, why a direct fusion of sulphanilamide with the common dibasic acids or their derivatives should not form such di-derivatives. This note summarises the results of the successful application of this simple method to the preparation of the di- as well as monosulphanilamido derivatives of the dibasic acids and their derivatives tabulated below:

The apparatus used in all these condensations was a hard-glass test tube fitted with an air-condenser, carrying a calcium chloride guard tube, and heated in an oil-bath till no more water, alcohol or ammonia as the case may be, was evolved. The products of the reaction were usually worked up by treatment with dilute hydrochloric acid to remove unchanged sulphanilamide, and purified either by solution in dilute sodium hydroxide and reprecipitation by dilute hydrochloric acid or by crystallisation from water or alcohol.

A rather interesting complexity in these reactions is the further condensation of the oxalyl disulphanilamide with an additional molecule of methyl oxalate. This compound has been analysed for its methoxy content and equivalent. In addition, the products of its hydrolysis have been identified to be oxalic acid and $N^4,N^{4'}$-oxalyl-disulphanilamide.

Sulphanilamide (2 moles)+ Dibasic acid or its derivative	Temp. and time of fusion	Products isolated	M.P. in °C.	Yield %	Percentage of Nitrogen	
					Calcd.	Found
Urea (1 mole)	160° for 6 hrs.	$CO(NH\cdot C_6H_4\cdot SO_2NH_2)(NH\cdot C_6H_4SO_2NH_2)$	290° (decomp)	71	15·13	15·06
Oxalic acid (1 mole)	160° for 2 hrs.	$CO\cdot NH\cdot C_6H_4\cdot SO_2NH_2$ $\vert$ $CO\cdot NH\cdot C_6H_4\cdot SO_2NH_2$	above 330°	60	14·07	13·83
Methyl oxalate (1 mole)	130° for 1½ hrs.	$CO\cdot NH\cdot C_6H_4\cdot SO_2NH_2$ $\vert$ $CO\cdot N\cdot C_6H_4\cdot SO_2NH_2$ $\vert$ $CO\cdot COOCH_3$	255° (decomp)	60	11·57 methoxy 6·40 equivt. 242	11·41 5·84 226
Ethyl malonate (1 mole)	160° for 3½ hrs.	$CH_2(CO\cdot NH\cdot C_6H_4\cdot SO_2NH_2)(CO\cdot NH\cdot C_6H_4\cdot SO_2NH_2)$	272° (decomp)	70	13·59	13·43
Malonic acid (1 mole)	125–130° for 6 hrs.	(1) $CH_3CO\cdot NH\cdot C_6H_4\cdot SO_2NH_2$ (2) $CH_2(CO\cdot NH\cdot C_6H_4\cdot SO_2NH_2)(CO\cdot NH\cdot C_6H_4\cdot SO_2NH_2)$	211–12° 272° (decomp)	20 5		
Succinic acid (1 mole)	150–160° for 4 hrs.	$(CH_2\cdot CO)(CH_2\cdot CO){>}N\cdot C_6H_4\cdot SO_2NH_2$	281–82° (decomp)	75	11·02	11·32
Ethyl succinate (1 mole)	No reaction					
Succinic anhydride (2 moles)	170° for 12 hrs.	$(CH_2\cdot CO)(CH_2\cdot CO){>}N\cdot C_6H_4\cdot SO_2NH_2$	284–85° (decomp)	94	11·02	10·83
Glutaric acid (1 mole)	140–160° for 8 hrs.	$CH_2(CH_2\cdot CO\cdot NH\cdot C_6H_4\cdot SO_2NH_2)(CH_2\cdot CO\cdot NH\cdot C_6H_4\cdot SO_2NH_2)$	257° (decomp)	73	12·73	12·22
Adipic acid (1 mole)	150–170° for 5 hrs.	(1) $CH_2\cdot CH_2\cdot CO\cdot NH\; C_6H_4\cdot SO_2NH_2$ $\vert$ $CH_2\cdot CH_2\cdot CO\cdot NH\cdot C_6H_4\cdot SO_2NH_2$	287° (decomp)	61	12·33	11·85
		(2) $CH_2\cdot CH_2\cdot CO\cdot NH\cdot C_6H_4\cdot SO_2NH_2$ $\vert$ $CH_2\cdot CH_2\cdot COOH$	178–79°	10	9·33 equivt. 302	9·14 300
Phthalic acid (1 mole)	170–200° for 8 hrs		322°	89	8·75 equivt. 320	8·59 312
Phthalic anhydride (2 moles)	170–200° for 30 hrs.		324°	89	8·75 equivt. 320	8·71 312

I wish to thank Dr. P. C. Guha for kindly suggesting the problem and Mr. P. Ramaswami Ayyar for his kind guidance and assistance.

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December 29, 1944.

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REVIEWS

The Velocity of Light. By N. Ernest Dorsey, of the National Bureau of Standards. (*Transactions of the American Philosophical Society*, Philadelphia, Vol. 34, Pt. I), 1944. Pp. 110, Figs. 20. Price $2.25.

As is well known, the finite velocity of light in its travel through space was first established from astronomical observations. The possibility of determining this fundamental constant of Nature by terrestrial and even in laboratory experiments naturally suggested itself. The first successful determinations of this kind were made in 1849 by Fizeau and by Foucault in 1862. The former used the toothed wheel method and the latter the method of the rotating mirror, descriptions of which will be found in any text-book on Optics. Fizeau's first determination was only a rough estimate, while Foucault found the value 298 megametres per second, which is within one per cent. of the value accepted at the present time. These methods, with various improvements, have been used by subsequent investigators in an effort to make a really reliable determination, *viz.*, Fizeau's method by Cornu (1872, 1876), and by Perrotin and Prim (1908), and Foucault's method by Newcomb (1880-82) and especially by Michelson (1878, 1879, 1882, 1924 and 1927) and by Michelson, Pease and Pearson (1935). A fundamental variation of the Fizeau method was initiated by Karolus (1925), the toothed wheel being replaced by a Kerr electro-optic cell. This new method has been used for definitive determinations by Karolus and Mittelstaedt (1929), Anderson (1937, 1941) and by Hüttel (1940). All these four determinations agree closely, the mean value for the velocity of light in vacuum being 299·773, the uncertainty not exceeding a few units in the last decimal place. Precisely the same result was given by the work of Michelson, Pease and Pearson, in which the velocity of light was determined in an evacuated tube, about a mile long. It is interesting to notice that the earlier determinations of Newcomb (1880-82) gave the mean value 299·78, though the uncertainty was greater, and that Michelson's successive determinations, except the very first preliminary one, made a progressively closer approach to the now accepted value.

Mr. Dorsey in the volume now under notice has made a thorough critical review of all the published investigations. His comments make it clear that all the earlier investigations prior to 1924 were affected by various uncertainties and systematic errors, and must, therefore, be considered as of historic interest only. The detailed discussion leads to the definitive value stated above. Incidentally, it is shown that the suggestions that have been put forward that the velocity of light in vacuum has progressively diminished (!) during the last century are absolutely without physical foundation.

The monograph is a most scholarly and useful production. C. V. RAMAN.

Everybody's Political What's What? By George Bernard Shaw. (Constable, London), 1944. Pp. 366. Price 10 *Sh.*

Notice of a book by this evergreen entertainer would scarcely have reached these columns but for a savage attack on science and medicine which must not pass without remark. Nobody with an open mind will quarrel with his quarrel with (1) any form of inoculation and (2) Pavlov's experiments on dogs: but to limit his review of science to these isolated and admittedly debatable subjects is, in the words of the Scots minister who prayed for rain, "fair rideeculous". There is no mention of the work—from which Mr. Shaw will have unconsciously benefited in his long life even more than an appreciative public has profited by Mr. Shaw's—of Faraday, Pasteur, Perkin, Marconi and the host of ancillary chemists, engineers, physicians and surgeons who have rendered more tolerable the day-by-day conditions of existence within the last hundred years.

To avoid all misunderstanding, however, it must here be said, and said with gratitude, that the book is a joyous feast of typical Shavian slapstickery which merits the closest attention of Mr. Everyman and Mrs. Everywoman. Because, embedded in the quartz of irony and impudence there runs the gold of wisdom and commonsense, bedecked with rollicking good humour and a kindliness of heart which Mr. Shaw, rather coyly, permits to emerge from time to time. How pleasantly this contrasts with the current mood of his co-sage, Mr. H. G. Wells.

It is all the more regrettable, therefore, that Mr. Shaw should write (p. 190), "I, an artist-philosopher, mistrust laboratory methods because what happens in a laboratory is contrived and dictated. The evidence is manufactured: the cases are what newspaper reporters of police cases call frame-ups. If the evidence is unexpected or unaccountable it is remanufactured until it proves what the laboratory controller wants to prove." This calumny shows that even Mr. Homer-Shaw may nod when treading some unfamiliar field such as the laboratory; and also the racecourse, where he blunders badly at the "Tote, in which gamblers deposit the sums they are prepared to stake on the horses they fancy. After the race, all the money staked on the winner is divided among its backers. The machine keeps the rest" (p. 112). Incidentally, it is revealed that Mr. Shaw lacks elementary knowledge of contract bridge when he declares, "Cardgames are games of chance; for though the players may seem to exercise some skill and judgment in choosing which card to play, practice soon establishes rules by which the stupidest player can learn how to choose correctly: that is, not to choose at all, but obey the rules". For this absurdity, Mr. Shaw deserves perpetual partnership with a stupid player.

Dismissing now the defects, and approaching the constructive aspects, it is the avowed purpose of this book to urge the necessity of government by councils of qualified persons chosen from panels, and subject to the sternest possible public criticism. "Government by ignorant good men may be worse than by cultivated bad ones" (p. 343). "For legislative purposes adult suffrage is out of the question, as only a small percentage of any population has either the requisite faculty or knowledge: but for ventilation of grievances, questioning of ministers and criticism of cabinets, suggestion of remedies and new methods, moving of resolutions and votes of confidence and the reverse, and generally for keeping the government in touch with the people, a representative popular parliament of men and women in equal numbers is necessary." This is commonsense, and could be fitted into Lincolnian democracy.

The plain man, smarting under the lash of this provocative octogenarian and then soothed by his genial smile, will rightly ask whether the philosopher's own remedy, if attainable, will really mitigate the world's pain. Too clear-sighted to accept the tedious popular slogan "equality of opportunity", he does believe in equality of income which, at the moment he places at the comfortable standard of £5,000 a year. Yet he writes (p. 135): "Civilization confers benefits on mankind; but it also imposes activities and efforts of which we are not all equally capable: indeed, of which some of us are not capable at all. Work has to be planned: decisions have to be made: temptations have to be resisted: complicated processes have to be understood. The capacity to meet these demands varies from individual to individual, and also from class to class when there are wide differences of education and income. Those who can find out what to do in organized business are scarce. Those who can find out how to do it are scarcer still. Men who are hopelessly at a loss until they are told what to do and how to do it are very common in any proletarian population. For them the choice is between docility and starvation."

This passage is an admirable synopsis of life's complexity, but is this complexity reconcilable with equality of income? Can these life-problems, in fact, be solved without any material incentive to their solution? Which brings us back to the wise old saying that by the time we are fit for socialism there will be no need for it. Mr. Shaw's powders are pleasurably administered with excellent jam. No thoughtful reader can fail to benefit from submission to this bracing and invectival whirlwind; and in a world of tottering institutions to be thankful for the survival of Mr. Shaw.

M. O. F.

Wolf-Children and Feral Man. By Rev. J. A. L. Singh and Prof. Robert M. Zingg. (Published by Harper Bros. for the University of Denoer), 1944. Pp. 379. Price $4.00.

More than two centuries back John Locke stated that a child is born with a few unconditioned reflexes and that it develops not only memory but ideas by the kaleidoscopic way in which sense experience plays upon its initially blank but receptive mind. From an entirely different method of approach Rauber also comes to the conclusion: "We must not forget that the human child learns more during the first two years of its life under the influence of his living surroundings than in all the entire period afterwards. The period of learning the foundations is, therefore, a very short one. The child has even begun to learn the language at this age. If those influences fail let us say until the fourth, sixth or tenth year, how would it be possible that this could be without influence in normal development of the brain?" The inter-relationship between Nature and Nurture has always attracted the attention of scientists, and especially in the case of Man it has given rise to conflicting interpretations. From historical times cases of human isolation have been reported. These fall under three distinct categories, *viz.*, infants reared and suckled by wild animals, children getting lost in forests and surviving by their own efforts and children denied human association by insane or cruel parents. It was Carl Linnaeus, the father of systematic Biology, who, in his tenth edition of *Systema Naturæ*, separated *Homo Sapiens ferus* from man and apes basing his conclusions on instances from history and myth. Nine instances, a few of which are considered of doubtful value by modern authorities, were available to him. These are: the bear-boy of Lithuania, the Hessian wolf-boy, the Irish sheep-boy, the Bamberger cattle-boy, wild Peter of Hanover, the Pyrenees boys, the girl of Cranenburg, the Songi girl from Champagne and Jean of Liege. The German naturalist Blumenbach in his review of the problem of the Feral man dealt with Linnaeus' data "inadequately and unfairly", owing, as one is led to suspect, to the use to which the concept had been put to by Jean Jacques Rousseau.

The rarity of the occurrence coupled with the fact that by the time the reports see the light of day in print, the real facts get mixed up with extraordinary untruths and contradictions led to a disbelief in their credibility. The finder is rarely the recorder of facts and this resulted in a rejection of the records as those of imposters or of congenital idiots.

Many cases of wolf-children have previously been reported from India, the earliest being that by Sir W. H. Sleeman. Just as to-day foreigners' views on India and Indians are enjoyed with a cynical humour by present-day intelligentsia, previous records of wolf-children reported on Indian testimony were presumed to be unreliable by readers in other parts of the World.

"No scientist would dream of actual experiment with a human subject under such rigorous control as removing all human association and contact. Cases of Feral man and certainly the present one of the wolf-children of Midnapore, offer objective data subject to this control of fundamental importance to theories of human studies." The first part of the book presents evidence of a crucial experiment start-

ed by a mother-wolf and continued by Rev. and Mrs. Singh.

On October 17th, 1920, Rev. Singh captured two wolf-children near the village of Godamuri. It was surmised that the elder was about eight years of age and the younger about a year and a half. They were brought to the Orphanage run by the Reverend and his wife and in the diary are recorded the results of the attempts to humanize these "wolf-girls". Amala, the younger, died a year later, but Kamala lived for nine years after her capture. The diary traces "the terrible strain that Kamala went through for years to drop off her wolf-conditioning to attain the human personality of a three-year-old at the chronological age of seventeen". It took nine years to develop in her the essentials of human personality such as rudimentary use of language, use of clothes, desire for human association and an upright carriage.

Though it is difficult to accept some of the conclusions of Rev. Singh, all the same one has to admire not only his altruism but also his attempt to throw much crucial light on many human problems.

In the second part Prof. Zingg gives a critical survey of all known Feral cases recorded uptil now.

The scientific facts which emerge as a result of the above study, if accepted, would act as a cold douche to militant politicians and communalists, for, after all, politics and religion appear to be only a sort of "conditioning" the brain, and hence the outlook.

There is no index.

The book is well got-up and deserves a place in every library.

M. K. Subramaniam.

Your Food. By M. R. Masani. (Tata Studies in Current Affairs, Tata Sons, Bombay), 1944. Pp. viii + 82. Price Re. 1.

This little eighty-two page, profusely and suggestively illustrated book, is planned to be the first of a series of publications which the illustrious and the munificient House of the Tatas have sponsored "with a view to stimulating interest in some of the most vital problems of India, and by the widespread dissemination of knowledge on such subjects, creating a body of public opinion which may, in time, influence policy and action". The pamphlet deals with "Your Food" which constitutes the fundamental and primary want of man.

In the course of the thirteen chapters which comprise the book, the author has tried to furnish convincing and scientifically accurate answers to some of the most important problems relating to food and food policy. The reader can get himself informed on questions like: Why do we eat? How much to eat? What is there to eat? What is a balanced diet?

The question of our supplies and deficiencies with regard to our food, the impoverishment of our soils and the low yields of crops therefrom, are all dealt with by the author in an original and effective manner, supported by facts and figures. The pathetic fact that decades of chronic starvation under which large masses of our population have suffered has undermined their morale and their sense of independence, has been brought home to the reader. To quote the author, "Is it any wonder then that the chronic starvation of which our people have been the victims for many generations has sapped their sense of sturdy independence and made it difficult for them to assert their right to free nationhood? As much as our internal divisions, perhaps, it is this undernourishment that keeps us from asserting ourselves and securing for India a free and equal position among the nations of the world".

Too little production of food, too many mouths to feed sums up the situation in our country; more food and better food should be obtained not only from our soils and from our herds but also from the vast expanses and depths of the ocean which encircles this peninsular subcontinent. The fishery resources of the Bay of Bengal, of the Arabian Sea and of the Indian Ocean still remain to be exploited. How to make the most of our slender food resources, is detailed in the twelfth chapter while the last one discusses the relation of the quality of food to income. Who does not like nutritive food and all of us can recognise and appreciate "quality" and choose our foods. This is bound up with economics, "with the fight for the abolition of poverty, which is one of the biggest crusades on which we as a nation should launch".

The book is written in a delightfully popular style; the facts presented are scientifically accurate; the economic data are both useful and illuminating. The author has earned the gratitude of all his readers, for the clear and successful way in which such a large volume of information has been presented with such lucidity and effectiveness. This is a book which should be translated into every one of the Indian languages, thus enabling our masses to get themselves enlightened on the important topic of "Our Food".

Venereal Diseases. By James Marshall. (Macmillan & Co., Ltd.), 1944. Pp. 348. Price 21/-

This elegantly got-up and lucidly written handbook gives precise diagnostic points, and detailed information regarding the available therapeutic measures and does not waste much space on the pathological or academic aspects.

In a country like ours, where medical relief in the rural areas is insufficient, and therefore specialist aid is scarce, the practitioner has to know correct diagnosis and details of therapeutic technique of almost all diseases. To him this handbook is admirably suited and will keep him informed of the latest methods of diagnosis and treatment of venereal diseases.

A later edition, we are sure, will give details of penicillin treatment, when penicillin will be made easily available to all practitioners.

M. S.

Possibilities of Increasing Food Production in Mysore. By Dr. B. Narasimha Iyengar, Retired Director of Agriculture in Mysore. (Reprinted from the *Mysore Information Bulletin*), October 1944.

This little pamphlet represents a thoughtful and highly practical contribution to the problem of increasing the production of food in

Mysore. The author, who is one of our leading authorities on the subject of Indian agriculture, invites attention to the urgent need of an application of the nitrogenous and phosphatic manures to the impoverished soils with a view to increase the acreage yield. The author has shown that there is little need for bringing new land under cultivation. "Even the agency set up by the Government of India for the 'Grow More Food' campaign came to the conclusion that there was a better chance of achieving their object by concentrating their attention on producing more per acre from lands under cultivation than by extending the area."

We commend this article to the earnest attention of all those interested in securing greater returns from our impoverished soils.

SCIENCE NOTES AND NEWS

The Indian Drugs Research Association, Poona, inaugurated early last year, has just issued a short report of its activities for 1944. The study of indigenous drugs offers to the scientific investigator a rich and promising field, and is of vital economic importance to an impoverished country like ours. The system of Indian medicine has already given to the world, a substantial number of potent drugs which are now being extensively employed in the remission of some of the refracting diseases. It has several more treasures, if only our scientists and the Government would organise an intensive study of the time-honoured drugs of lasting repute. The Indian Drugs Research Association represents a praiseworthy organisation intended to advance this object.

Workers experienced in this field have felt that the methods which are now adopted for elucidating problems connected with the study of indigenous drugs have to be replaced by a system of analysis and investigation which is more fruitful and rapid, while the adoption of the present methods may lead to unexpected results of far-reaching value, the immediate objective is often bypassed. A new and fresh approach to the problem is essential; at the moment the orthodox course of investigation is painfully cumbersome, pitifully slow and frightfully extravagant.

One is tempted to speculate upon the methods of investigation which were adopted by the founders of the ancient systems of medicine. If a revival of these methods—now extinct—could be secured through the co-operation of the progressive and enlightened leaders of Hindu and Unani systems of medicine, and a new system of investigation evolved by modifying the methods in the light of modern technique, the Indian Drugs Research Association would have contributed substantially to the study of Indian drugs.

University of Madras: The Ramanujan Memorial Prize, 1945.—"The Ramanujan Memorial Prize" of the value of Rs. 500 will be awarded for the best essay or thesis written on any branch of Mathematics embodying the result of the personal investigations of the author and containing clear evidence of independent and original research. The prize is open to all persons born or domiciled in India. Intending competitors should forward their essays or theses so as to reach the Registrar not later than the 1st December 1945.

Endowment Lectures, 1945-46.—The Syndicate will proceed shortly to select persons to deliver lectures under the following endowments for the year 1945-46. Applications for lectureships will be received by the undersigned not later than the 1st March 1945. Applicants are requested to give full particulars regarding their qualifications and the subject selected by them for the lectures. The lectures are to be delivered before January 1946. Separate applications should be submitted for each lectureship.

The principal terms and conditions of award are given below:—

(1) *The Maharaja of Travancore Curzon Lectureships.*—Three lectureships of the value of Rs. 250 each relating to Medicine (Clinical), Engineering, and Agriculture. Applicants should be graduates of the University.

(2) *The Sir Subrahmanya Ayyar Lectureship.*—Value Rs. 250. The lectures should be on a subject connected with Ancient Indian History and Archælogy. Applicants should be graduates of the University.

(3) *The Sankara Parvathi Lectureship.*—Value Rs. 250. The lectures should be on a subject connected with Ancient South Indian History. Applicants should be graduates of the University.

(4) *The Sir William Meyer Lectureship.*—Value Rs. 1,500. A course of not less than six lectures should be delivered on a subject in Economics. Half of the remuneration will be paid after the delivery of the lectures and the other half after the publication of the lectures.

(5) *The Principal Miller Lectureship.*—Value Rs. 350. A course of not less than two lectures should be delivered on a subject dealing with the exposition of the Inner Meaning of Human History as disclosing the one increasing purpose that runs through the ages.

(6) *The Dr. Elizabeth Matthai Lectureship.*—Value Rs. 300. A course of not less than three lectures should be delivered on a subject embodying the results of original investigation in some branch of Medicine and Surgery. Preference will be given to a subject having special reference to the requirements of women and children.

(7) *The Sundaram Ayyar-Krishnaswami Ayyar Lectureship.*—Value Rs. 200. The lectures should be on a subject relating to (*a*) Public International Law, or (*b*) Inter-State Relations of Indian States and British Indian Provinces, or (*c*) Comparative Legislation.

(8) *The Diwan Bahadur K. Krishnaswami Rao Lectureship.*—Value Rs. 200. The lectures should be on a subject relating to some aspect of Ancient Indian Cultures studied from original sources.

(9) *The Father P. Carty Lectureship.*—Value Rs. 200. A course of not less than two lectures should be delivered on a subject in

Economics with particular reference to Indian conditions.

Further particulars from: The Registrar, University Buildings, Chepauk, Madras.

At the Annual Meeting of the Royal Asiatic Society of Bengal held on 5th February 1945, Dr. P. C. Bagchi, M.A., Dr.es.Lettres (Paris), of the Calcutta University, was elected an Ordinary Fellow of the Society.

Joy Gobind Law Memorial Medal has been awarded to Rai Bahadur Dr. S. L. Hora, D.Sc., F.N.I., Director of Fisheries, Bengal, in recognition of his conspicuously important contributions to our knowledge of Ichthyology of Asia.

Paul Johannes Bruhl Memorial Medal was awarded to Dr. N. L. Bor, D.Sc., F.N.I., formerly Forest Botanist, Imperial Forest Research Institute, Dehra Dun, for his important piece of Original Research in the Graminæ and the Econogy of Indian Plants.

Dr. Bimala Churn Law Gold Medal has been awarded to Dr. D. R. Bhandarkar, M.A., Ph.D., F.R.A.S.B., formerly Carmichael Professor of Ancient Indian History and Culture, Calcutta University, for his conspicuously important contributions to Ancient Indian History and Archæology.

Sarat Chandra Roy Memorial Medal was awarded to Dr. Verrier Elwin, D.Sc., F.N.I., of the Bhumijan Seva Mandel, Patangarh, C.P., for his meritorious and many-sided contributions to the study of Cultural Anthropology of India.

The Elliott Prize for Scientific Research for 1944 has been awarded to Dr. S. K. Chakrabarty, D.Sc., of the University College of Science and Technology, Calcutta, and the subject of the Prize for 1944 was for Mathematics.

Dr. Meghnad Saha, D.Sc., F.N.I., F.R.S., F.R.A.S.B., has been elected President of the Royal Asiatic Society of Bengal for the year 1945.

SEISMOLOGICAL NOTES

Among the earthquake shocks recorded by the seismographs in the Colaba Observatory during the month of January 1945, there were five of slight and one of moderate intensities. The details for those shocks are given in the following table:—

MAGNETIC NOTES

Magnetic conditions during January 1945 were slightly less disturbed than in the previous month. There were 20 *quiet* days, 9 days of *slight* disturbance and 2 days of *moderate* disturbance, as against 14 quiet days and 17 days of the slight disturbance during the same month last year.

The quietest day during the month was the 25th and the day of the largest disturbance the 29th.

The individual days during the month were classified as shown below:—

Quiet days	Disturbed days	
	Slight	Moderate
2, 5, 7, 8, 11–14, 16, 18–25, 27, 30, 31	1, 3, 4, 6, 9, 10, 17, 26, 28	15, 29

No magnetic storms occurred during the months of January in the years 1944 and 1945.

The mean character figure for the month of January 1945 was 0·42 as against 0·55 for January of last year.

We acknowledge with thanks receipt of the following journals:—

"Chemical Products and Chemical News," Vol. 7, Nos. 11-12.

"Indian Farming," Vol. 5, No. 6.

"Transactions of the Faraday Society," Vol. 40, Pt. 11.

"Indian Forester," Vol. 70, No. 12; Vol. 71, No. 1.

"Bulletin of the Indian Central Jute Committee," Vol. 7, No. 9.

"Indian Medical Gazette," Vol. 79, No. 11.

"The Review of Applied Mycology,' Vol. 23, Pt. 10.

"Bulletin of the American Meteorological Society," Vol. 25, Nos. 7-8.

"Journal of Nutrition," Vol. 28, Nos. 4-5.

"Nature," Vol. 154, 3914-17.

CORRECTION

Vol. 14, *No.* 1 (*January* 1945)

Article on "A Chlorosis of Paddy (*Oryza sativa* L.) due to Sulphate Deficiency", p. 10, column 2, line 15 from botton: *for* "ammonium sulphate" *read* "Ammonium Phosphate".

Date	Intensity of shock	Time of origin I.S.T.	Epicentral distance from Bombay	Co-ordinates of the epicentre	Depth of focus	Remarks
		H. M.	(Miles)		(Miles)	
4	Slight	11 51	1030			
11	Slight	08 33	1495			
13	Moderate	01 08	4110	Epc: Near Honshu, Japan		Reported felt in Honshu.
13	Slight	18 27	3690			
16	Slight	20 07	4045			
17	Slight	21 32	3705			

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CURRENT SCIENCE

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SCIENTIFIC AWAKENING

PROFESSOR A. V. HILL'S dynamic visit to twelve Indian cities between mid-November, 1943, and early April, 1944, gave much comfort to the scientific community, and he now gladly testifies to the great goodwill universally manifested towards his mission. This lay in acquainting himself with the state of scientific and industrial research in this country, and thus equipping himself to advise the Secretary of State on the organization of scientific endeavour as a part of Indian post-war reconstruction; and on its co-ordination with similar activities in Britain. His report* is rich in proposals directed towards development of Indian resources in men and material; its interest and importance are outstanding.

Immediately on his return, Prof. Hill procured an official invitation to a group of Indian scientists led by Sir Shanti Swarup Bhatnagar, Head of the Board of Scientific and Industrial Research, to visit British factories, laboratories and institutions concerned with linking scientific procedure to public needs. This embassy having later journeyed to the United States and Canada, returned to India in mid-February, and it is reasonable to hope that its members may come to be regarded as apostles of a new era; for their unique experience will authorise them to select and urge the adoption of such among Prof. Hill's proposals as they deem best applicable to Indian conditions.

The first of these relates to medical education, upon which as a physiologist Prof. Hill is highly qualified to judge, and his verdict is that the development of scientific medicine requires one first-class department of physiology at which teachers and research workers of a new standard and a new outlook will be reared, and thence distributed throughout the country. There is the same need for intensified "anatomy and pharmacology in the medical colleges; and there is little provision for psychology. Biochemistry is in rather better case because it has developed a certain independence of medicine, has had a special part to play in relation to nutrition and has connections with agriculture and industry. It will be a pity, however, if biochemistry is encouraged to develop mainly as a branch of chemistry in order to avoid the narrowness and penury of the medical connection. It should be just as closely in touch with physiology, pathology and medicine as with chemistry, agriculture and industry."

This proposal calls for an All-India Medical Centre, "an Indian Johns Hopkins", throughout staffed by the ablest people available anywhere, employed full-time and adequately paid. The selected students should be graduates in arts or science, and when requiring monetary help should receive enough to cover their long training with the aim of producing future leaders among medical teachers, researchers and practitioners. Moreover, selection should be regardless of all considerations other than quality, because "if any reason whatever were accepted for admission other than ability and character the project would lose at once a large part of its value." Greatly improved health being India's first need, the All-India Medical Centre should be established at a cost of Rs. 7 to 10 crores in the capital city, and might form a suitable national memorial to the Indian Forces, whose gallantry in World

* *Scientific Research in India.* Professor A. V. Hill, M.P., Sc.D., Sec.R.S. (Government of India Press, Simla), 1944, pp. 40.

War II has evoked gratitude and admiration throughout the Commonwealth. A substantial part of the running cost might be met by accommodation for paying patients as at the Mayo Clinic, where fees are adjusted to the patient's income. A specialised section for the clinical study of malaria, with (say) 200 beds, would form an appropriate recognition of both India's Public Enemy No. 1 and the large part this country has already played in coping with tropical disease.

The second major proposal envisages a Central Organization for Scientific Research, which would embrace collectively the functions now exercised in England by the Medical Research Council, the Department of Scientific and Industrial Research, the Agricultural Research Council, the War Cabinet Scientific Advisory Committee, and the Surveys. It would work under the Hon'ble Member for Planning and Development and would comprise six Research Boards, namely, Medical, Agricultural, Industrial, Surveys and Natural Resources, Engineering, and the War Research Board. After outlining the composition and duties of these boards, Prof. Hill indicates the working of committees, including those for grants and studentships, showing also how a Scientific Consultative Committee, recruited from each Board and fortified by six unofficial members could usefully advise the Hon'ble Member.

It will be recognised that this proposal, if adopted, will separate research from direct control of the departments under which it is at present practised, a policy which has been closely examined by Prof. Hill and for which he adduces cogent arguments. He believes that any temporary disadvantages caused by the detachment would be liberally compensated by "more and better research", following improved co-ordination of the various branches of inquiry resulting from disclosure of existing gaps and weaknesses. Moreover, departments now benefiting by such research as they do control could retain this advantage through a Development or Improvement Council set up within the department to apply research results to the various practical problems in view. Such a council, if including members of the relevant Research Board, would offer the twofold benefit of (1) keeping the Board aware of practical needs and (2) ensuring that research results come to the notice of those whose duty it is to apply them. The "more and better research" would follow release from the trammels of departmental need, as it is "a mistake in general to tie up research too directly to the solution of immediate practical problems."

Furthermore, assemblage of all research branches in a central organization provides one inestimable advantage which is not mentioned in the report. It would greatly facilitate that association and consultation among the scientific personnel which Indian distances now preclude, and which have been immensely helpful to geographically more fortunate nationals. The Indian Science Congress Association dating from 1914 was designed to mitigate the distantial handicap from which most Indian scientists are compelled to suffer: but even that provides only one fleeting annual alleviation of a few days, and cannot embrace all the juniors, who are the very people most needing the benefit. A Central Organization for Scientific Research located at Delhi with an adequate library would supply an increasingly fertile pool of science personnel and practice which might ultimately be comparable with those of London, Washington, Moscow and Paris. From this concentration of effort and opportunity special benefit would accrue to investigators of those regions in which two or more branches of science are intermingled. Looking further into the future, inevitable social exchanges between members of the science group and their governmental neighbours may be calculated to produce reciprocal enlargement of sympathy and outlook.

It cannot be denied that there is unlimited scope for this bilateral broadening of outlook and sympathy. Owing to the common exclusion of sciences from school curricula, many people attain highly responsible positions in the community without any clear idea of the mental processes which yield scientific discoveries, and with no conception whatever of experimental methods. They could not, for example, describe the very simple operation of resolving air into nitrogen and oxygen although they depend on air for every minute of their existence. It is even more significant and regrettable that they have no curiosity in the matter. A glaring example of this unhappy principle has lately emerged in a popular book whose world-renowned author—presumably serious for a moment—roundly charges researchers with manufacturing their evidence; in laboratory slang, with "cooking their results". The shocking aspect of this almost incredible episode is that, owing to the high entertainment value of the author in question, and his usually penetrating vision, this calumnious dictum will reach a very large circle of readers, most of whom will fail to diagnose the mental aberration and will rashly assume that because he is a super-sparkling playwright his opinion of other matters must be trustworthy.

From an early stage of the report there springs the question, Where shall we find the men? On a much larger scale it haunts the Sargent Scheme, and is foundational to both compulsory national education and scientific awakening. Among intellectual disasters consequent on the war has been the isolation of India during five years, and "one of the most urgent needs, therefore, of Indian science, medicine, technology and industry is for young teachers, research workers and members of technical staffs to be provided once more, as soon as conditions allow, with facilities for advanced study abroad; if possible, on an enlarged scale in order (*a*) to make up for recent restrictions and (*b*) to meet the greater needs of the future." Following the lately returned Foreign Mission of Indian Scientists there is happily no doubt that carefully selected Indian practitioners will be welcome in the laboratories of Britain and the United States, the only obstacle to their acceptance being limitations of space arising from arrested training of those nationals, and consequent overcrowding of laboratory accommodation,

accentuated by the priority claimed in England for domestic housing.

Any outlay on this project by Government within the limits of available space will be a splendid investment. During many decades preceding World War I it had been common practice for advanced British and American students of science to enter German universities, even after their own teaching personnel and laboratory equipment had attained the German level: besides improving their knowledge of the language such students benefited by observing another way of life. Many years —perhaps another generation—must pass before German universities again become harmoniously accessible by foreigners, and meanwhile Indian students must be liberally subsidised to enjoy such facilities as may be obtainable elsewhere. This would not only provide India with a pcol of technicians trained in all branches of science and medicine, but would lead to an improved mutual understanding of East and West. To promote these and other contacts, Prof. Hill advises establishment of an Indian Scientific Office in London, co-operating with the British Central Scientific Office in Washington, and thus enabling India to profit by American experience in soil-conservation, irrigation, hydro-electric developments, pest-control and many other problems common to the American Continent and India. Another factor in assembling a reservoir of trained technicians suggested by Prof. Hill is the provision of facilities for technical training at all important centres, ancillary to a few technical institutes of the highest possible standing; either newly constructed, or developed from existing ones, of which he considers the Indian Institute of Science, Bangalore, to be the one approaching most closely to the ideal sought. The principle is the same as that underlying the proposal for an All-India Medical Centre noticed above, and "the cost will be considerable, but if Indian industry and agriculture are to be developed to the highest level by Indians, and if Indians of the required quality are to staff the new national laboratories to be built under the Board of Scientific and Industrial Research after the war, then Indians must be trained to the highest level themselves. Nationalist fervour cannot replace first-class scientific ability and technical training."

Scientific awakening has come to other nations through the war, and India must not lag behind. Addressing the East India Association in July 1944 on the results of his Indian mission Prof. Hill gave his emphatic summary in the words, "Scientific Development or Disaster". Faced with the standing threefold menace of ignorance, ill-health and malnutrition, India is threatened with the future calamity of a population overflowing the limits of her agricultural resources, because one immediate result of improved nutrition is reduced mortality. "In quality and calories together India needs at once at least 50 per cent. more food than she now has; give her that and her population will increase not by 15 per 1,000 per annum but by 20 or 25—it is already 20 in the Punjab. Then in 30 years or so the food supply will have to be doubled again, to be three times what it is now." A threefold increase in thirty years demands a stupendous national effort. New land must be brought into cultivation involving irrigation, and proper maintenance to avoid erosion. Roads, railways and bridges must be built, and transport multiplied. Wide improvement in the breeding of plants and animals must be effected, and insect-pests mercilessly combated. Soil chemistry must be studied and applied. Every known means for battling waste must be operated, so that all useful ingredients may return to the land. Afforestation must be stimulated, if only to avert the lamentable destruction of cowdung as fuel and redirect it to its proper destination, the soil.

There are many other matters discussed by Prof. Hill in his report, including Indian scientific societies and the various ways in which Government might assist and encourage them; for instance, by purchasing a certain mileage of air-travel for distribution among such bodies. His fruitful, sympathetic and stimulating visit followed by this wealth of practical proposals, will provide abundant material for reflection, discussion and construction during many years to come, the whole event being unique in the scientific life of this country. In conclusion, it is worthwhile to quote a significant passage in Prof. Hill's preface to the report: "I have assumed throughout that the scientific method, rightly and confidently used, will provide the framework within which national development will be planned by Indians for India. In their task they can be sure of the co-operation and goodwill of their scientific colleagues elsewhere. No other method can possibly succeed."

M. O. F.

ADVANCED STUDIES OVERSEAS

ARRANGEMENTS, it is understood, are now complete for sending students overseas for advanced studies. In addition to the provision made for stipendary students, the Government of India are also making arrangements for assisting in placing in foreign institutions of those students who desire to proceed overseas for advanced studies at their own expense.

The Government of India, in addition to the students sponsored by Provincial Governments, will send overseas a number of students who will receive adequate stipends for further education and training in various branches of Technology, Applied Science and Agricultural subjects. Government servants will also be eligible for stipends, and they may also be sent overseas at their own expense.

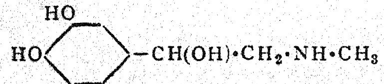
Applications are being invited to reach the Selection Board (Overseas Students) set up by Education, Health and Lands Department by April 15, 1945, on a special form which has been included in a booklet *Information for Students Desiring to Proceed Overseas for Advanced Studies* (1945), being issued by the Manager of Publications.

THE SYMPATHOMIMETIC GROUP OF DRUGS

By S. RAJAGOPALAN

(Department of Pure and Applied Chemistry, Indian Institute of Science, Bangalore)

ONE of the earliest and possibly best known studies in correlating chemical structures and pharmacological behaviour was made with compounds that produce a rise in blood pressure. Interest in these compounds was aroused when Oliver and Schaefer[1] in 1894 and Scymonovicz[2] independently in 1895 found that extracts of the suprarenal glands, when injected intravenously in experimental animals, caused a swift and precipitate rise of blood pressure and produced all the changes which occur when the animals are preparing for battle, such as the quick pulse, the dilated pupil and the inhibition of the peaceful activities of the abdominal viscera. The subsequent analytical[3] and synthetic[4,5] experiments have proved conclusively that the active principle, responsible for this effect, *viz.*, adrenaline, possesses the structural formula (I).



(I)

More recently, the discovery of its possible function as a transmitter of certain nervous impulses has played a fundamental part in the evolution of physiological and pharmacological concepts.

Before 1905 the existence of internal secretions of certain glands had been proved by circumstantial evidence, but nothing was known in regard to the chemical composition of the active principles responsible for their vital physiological activities. Apart from the demonstration of the comparatively simple composition of adrenaline, it was the first hormone to be synthesised and there is no doubt that this rapid success with the chemistry of adrenaline gave an impetus and encouragement to the successful chemical study of other hormones.

While the interest in adrenaline is usually associated with its presence and functions in the higher animals, it is found in structures other than the suprarenal glands. Abel and Macht,[6] and many other workers have shown the presence of adrenaline or similar bodies in the venoms of different toads. Collip[10] has demonstrated the presence of an adrenaline-like substance in the prostate gland of the bull.

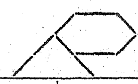
While the fame of adrenaline was thus steadily rising, Abelous *et al.*[11] made the interesting observation that extracts of putrefied meat also contained a substance that produced a rise in blood pressure. Barger and Dale[12] identified the active ingredients as two definite compounds, *iso*amylamine and tyramine. Since both may be derived by putrefactive processes from the amino acids leucine and tyrosine respectively, they were led to investigate other bases of putrefactive origin and also substances structurally related to adrenaline and tyramine: their results[13] first showed that an intimate relationship existed between the physiological activity of compounds possessing structural similarity. Because all of the substances investigated caused a rise in blood pressure by constricting the muscular lining of the arterioles, Barger and Dale described them as "Sympathomimetic", a term which is now in the vocabulary of all physiologists and pharmacologists.

During the fourteen years following the work of Barger and Dale in 1910 nothing of particular interest developed; known compounds were more intensely investigated and occasionally new ones, without special merit, were introduced. Meanwhile, adrenaline was becoming more firmly established and was being more extensively used than any other compound in physiological and chemical investigations, thereby illustrating the important position occupied by adrenaline in therapeutics, diagnoses and physiological experiments and even as a chemical reagent. However, in 1923, Chen[14] demonstrated that a decoction of the Chinese Ma Huang, a plant of the ephedra species, containing the active principle ephedrine, produced an action on blood pressure simulating that of adrenaline. Chen and Schmidt, the modern sponsors of ephedrine, have covered the history, chemistry and drug action of ephedrine in a monograph.[15]

Once the chemical structure of adrenaline has been elucidated it was natural that attempts should have been made to determine whether the molecule in its entirety was necessary for exerting the particular action of adrenaline. Much of the ground was covered by the pioneer work of Barger and Dale.[13] The molecule of adrenaline is such as to have encouraged the ingenuity of organic chemists, who have prepared a series of over 200 substances containing most of the permutations and combinations of the peripheral groups, of which the following are better known:—

All these substances have pharmacological action like adrenaline in varying degrees. Some of them which have been adequately covered in medical texts and have formed the subject of some excellent reviews[16] recently, have great advantages over adrenaline as therapeutic agents.

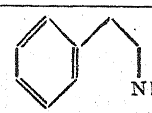
An examination of the group reveals an interesting relationship between chemical structure and pharmacological action. With an ethylamine side chain, the result of adding hydroxyl groups to the benzene ring is to increase the intensity but diminish the duration of pressor action. It can also be seen from the table that the addition of a single hydroxyl group, especially if it be in the *m*-position, increases the intensity but diminishes the duration of action. It is interesting to note that the stability of the compound is diminished if the hydroxyl groups are attached to the benzene ring; this explains why adrenaline solutions cannot be sterilised by boiling, whereas for example, those of neosynephrine (No. 4) can. It will be noticed that the first eight compounds have a methylene, $-CH_2-$, group in the α-position to the amino group in the side chains. In the remaining compounds, one of the hydrogen atoms of this group is replaced by a methyl radical, which has the effect of prolonging the duration of the pressor effect, although

No.	Name			—CH	— CH	— NH	Pressor Activity (Adrenaline = 1)	Pressor Duration (Adrenaline = 1·a
1	β-Phenyl Ethylamine	H	H	H	H	H	1/200–1/80	3–4
2	Tyramine	HO	H	H	H	H	1/100–1/20	2
3	Synephrin	HO	H	H	H	CH_3	1/50	10
4	Neosynephrin	H	H	HO	H	CH_3	1/25	5
5	Sympatol	HO	H	HO	H	CH_3	1/100–1/25	4
6	Epinine	HO	HO	H	H	CH_3	1/12	2
7	Arterenol	HO	HO	HO	H	H	3/2	2
8	Adrenaline	HO	HO	HO	H	CH_3	1	1
9	Benzedrine	H	H	H	CH_3	H	1/300–1/100	5–10
10	Propadrine	H	H	HO	CH_3	H	1/[illegible]00–1/60	7
11	Ephedrine	H	H	HO	CH_3	CH_3	1/300–1/100	7
12	Veritol	HO	H	H	CH_3	CH_3	1/30	10
13	Corbasil	HO	HO	HO	CH_3	H	1/4	2
14	Methylenedioxy, β-phenyl *iso*propylamine	O \ CH_2	O /	H	CH_3	H	1/400	10

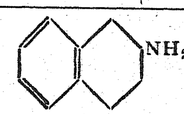
the intensity of the latter is slightly diminished. It has recently been shown that adrenaline is readily destroyed in the body by an oxidase, which attacks the side chain and thereby inactivates it pharmacologically.[17] At the same time it was shown that this oxidase attacks phenyl ethylamine, tyramine, sympatol and epinine (Nos. 1, 2, 5, 6), but not benzedrine, ephedrine or corbasil (Nos. 9, 11, 13), which have a methyl group in the α-position. This explains why the last named compounds have more prolonged effect in the body and perhaps why, unlike adrenaline, they are active when orally administered.

Adrenaline has practically no action on the central nervous system, but ephedrine and especially benzedrine have a marked stimulant action. Increased stimulation of the central nervous system is caused by compounds in which the benzene ring is not substituted, *e.g.*, benzedrine, propadine and ephedrine (Nos. 9, 10, 11) and in compounds containing an *iso*-propyl side chain, $-CH_2.CH(CH_3).NH_2$. The stimulant action is enhanced by introducing a methylenedioxy group, $-O.CH_2.O-$, into the benzene ring (No. 14), or replacing this by a cyclohexanyl nucleus. Such compounds which have recently been prepared cause marked acceleration of respiration and increase of motor excitement.

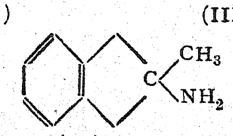
In examining the general pharmacological activities of this group of bases, one cannot fail to be struck by the regularity with which the atom-pattern, -CH.CH.NH- occurs in their molecular architectures. However, sympathomimetic activity is not exclusively restricted to the β-phenyl-ethylamine derivatives. Fourneau,[18] among others, has drawn attention to the way in which this type of aralkyl structure is usually accompanied, in even *nonbenzenoid* substances, with characteristic sympathomimetic activity. Thus, this activity which is observable in β-phenyl-ethylamine[13] (II) is more strongly pronounced in *ac*-tetrahydro-β-naphthylamine[19,20] (III) and intense in methyl-amino-hydrindene[21] (IV).



(II)



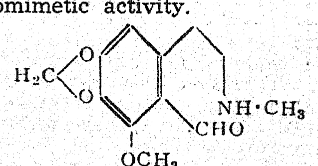
(III)



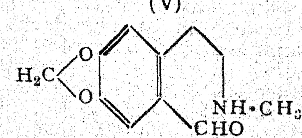
(IV)

The activity of tetrahydro-β-naphthylamine has been attributed to its being a derivative of β-phenyl ethylamine (II) in addition to its resemblance to γ-phenyl propylamine and cyclohexenylamine.[19] The high activity of methyl-amino-hydrindine (IV) has been explained on the basis of its being *doubly* a β-phenyl-ethyl-amine. Curiously enough, this activity, unlike that of phenyl-ethylamine, is not enhanced by the entry of a hydroxyl group into the aromatic ring.

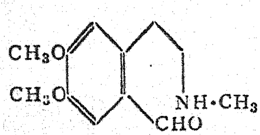
Evidence of this interesting phenomenon is also to be seen among the group of *iso*quinolines,[22] of which β-phenyl ethylamines constitute the precursors. The structurally related bases, cotarnine (V), hydrastinine (VI), the hydrastinine-like base (VII) and norhydrohydrastinine (VIII) exhibit varying grades of sympathomimetic activity.



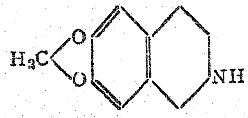
(V)



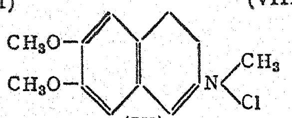
(VI)



(VII)



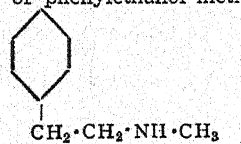
(VIII)



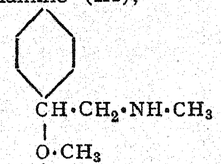
(IX)

Hydrastinine, which is an astringent and styptic, is used chiefly in uterine hæmorrhages. Cotarnine is of importance in medicine as a styptic and as a uterine sedative and is known as 'Stypticine'; its phthalic acid salt also finds use under the name 'Styptol'. The chloride of (VII), 6 : 7-dimethoxy-2-methyl-3 : 4-dihydroisoquinolinium chloride (IX), has been introduced in practice as "Iodal". It causes a rise of blood pressure and renders the heart-beat slower and stronger.

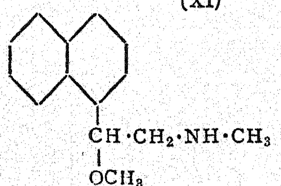
The activity of β-naphthyl-ethylamine derivatives was investigated by Madinaveitia.[23] By comparing the activity of β-phenyl-N-methyl-ethylamine (X) with the methyl ether of phenylethanol-methylamine (IX),



(X)

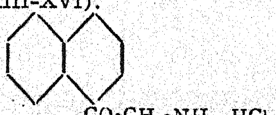


(XI)

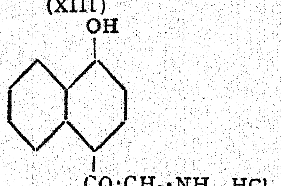


(XII)

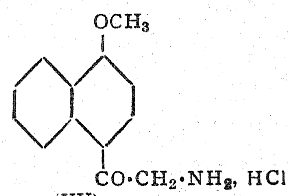
he showed that the introduction of the methoxyl group in the side chain did not change the sympathomimetic activity; but if the α-naphthyl nucleus (XII) was substituted for the phenyl group, the activity was increased about forty times. Having found the naphthyl compound so active, Madinaveitia compared the activities among themselves, of four other derivatives (XIII-XVI).



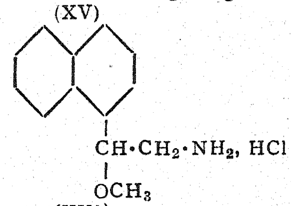
(XIII)



(XIV)



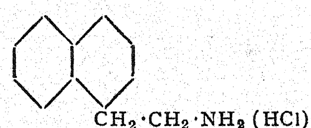
(XV)



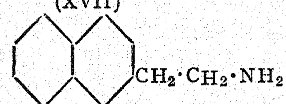
(XVI)

He found that the introduction of the hydroxyl group *para* to the side chain (XIV) greatly increased the activity and that etherification of the phenolic hydroxyl (XV) greatly reduced the intensity, the ketone (XIII) being much less active than the methyl ether of the corresponding alcohol (XVI).

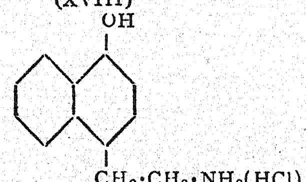
Although considerable time has passed since the isomeric naphthyl-ethylamines (XVII and XVIII) have been synthesised,[24] their sympathomimetic potentialities do not appear to have been explored. 4-Hydroxy naphthylethylamine (XIX), the tyramine analogue of the naphthalene series, was synthesised by Windaus[25]



(XVII)



(XVIII)

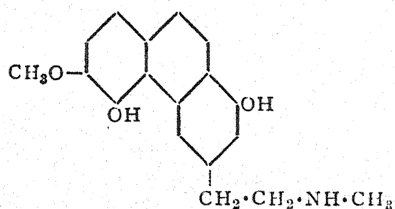


(XIX)

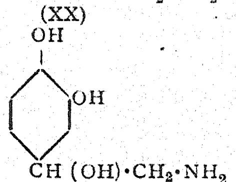
but, surprisingly and apparently in conflict with the findings of Madinaveitia, it possesses only a slight activity.

Since the work reported by Rajagopalan on the synthetical aspects of sympathomimetics derived from naphthalene[26] and their pharmacological examination, Day and his collaborators[27] have reported the synthesis of a few derivatives of naphthyl aminoethane but presented no pharmacological data on these compounds.

Hildebrandt[28] reported that thebainine (XX), a derivative of β-phenanthril-ethylamine, has a general reaction towards rabbits like that of 3 : 4-dihydroxy phenyl ethanolamine (XXI):—



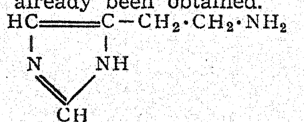
(XX)



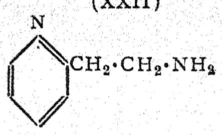
(XXI)

Recently, a small number of ethanamine derivatives of phenanthrene, as also that of dibenzofuran, have been revealed but these compounds were examined only for their analgesic activities.[29]

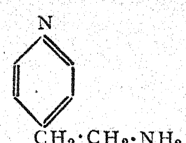
Ever since the demonstration of the remarkable physiological effects, particularly on blood pressure and the uterine muscle, of histamine[30] (XXII), isolated[31] from ergot of rye and later synthesised by Pyman,[32] it has been considered desirable to prepare similar compounds possessing the ethanamine chain linked to heterocyclic rings other than iminazole. Several such bases have already been obtained.



(XXII)



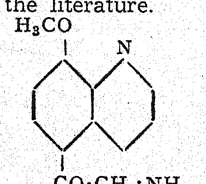
(XXIII)

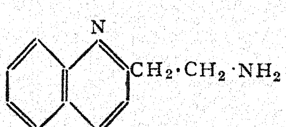


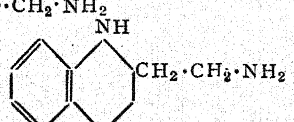
(XXIV)

Of the β-2-, and β-4-pyridyl ethylamines synthesised[33] with the object of ascertaining their suspected activity, it has been found[34] that, whereas the β-2-derivative (XXIII) did not behave like adrenaline but rather like histamine, the β-4-isomer, (XXIV) produced a pressor response similar to but weaker than that of adrenaline.

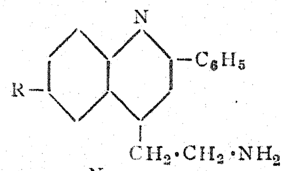
A set of ethanamine derivatives of quinoline and isoquinoline have already been described[35] in the literature.

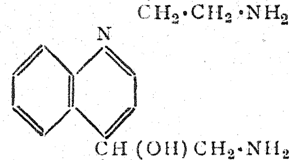


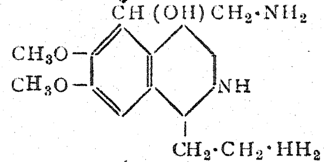




(XXV)





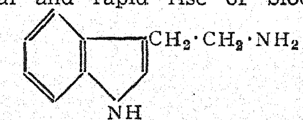


(XXVI)

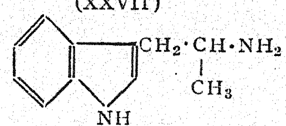
(R = H or OCH_3)

Quinolinyl ethanolamine (XXVI) was found to act on the blood pressure as does phenyl ethanolamine, whereas β-2-quinolyl ethylamine (XXV) possesses an activity one-hundredth of that of adrenaline.[36] The remaining compounds in this series do not appear to have been so far tested.

β-Indolyl-ethylamine (XXVII) was found[37] to dilate the pupil markedly and produce a substantial and rapid rise of blood pressure



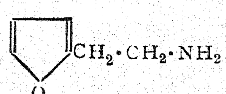
(XXVII)



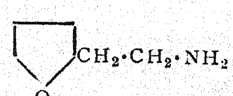
(XXVIII)

while the α-methyl derivative of indolyl-ethylamine (XXVIII) produced[38] a rise in blood pressure by vaso-constriction, contracted the uterus and stimulated intestinal movements.

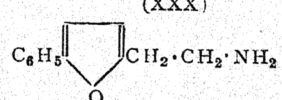
Windaus and Dalmer[39] found that furyl ethylamine (XXIX) produced only a short-lived fall in blood pressure and that its tetrahydro derivative (XXX) was without any effect.



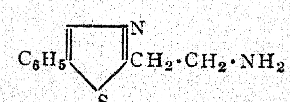
(XXIX)



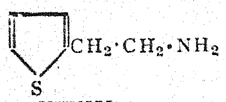
(XXX)



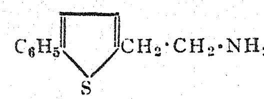
(XXXI)



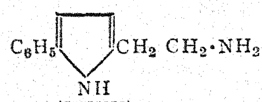
(XXXII)



(XXXIII)



(XXXIV)



(XXXV)

Hinegardner and Johnson[40] have prepared thiazole bridges of adrenaline- and tyramine-like bodies (XXXII) which they reported possessed pharmacological interest. Thienyl ethylamine (XXXIII) was found[41] to be as active as the phenyl analogue, β-(5-phenyl-) furylethylamine (XXXI), and analogous derivatives of thiophene (XXXIV) and pyrrole[42] (XXXV) were found[43] to be pressor-active. Thienyl and furyl-*iso*propylamines have recently been stated[44] to be similar in their action to phenyl *iso*propylamine.

The investigations in the field of the sympathomimetics, correlating chemical constitution with physiological activity, have been of considerable interest. They alone, more than similar studies in other groups of medicinal compounds, have so far lent themselves to almost rigorous interpretation and made possible the theoretical prediction of the physiological properties of a related member of the sympathomimetic group based on previous knowledge of its chemical structure. Instances of a large measure of actual experimental realisation of many such predictions concerning sympathomimetic action are rather plentiful. As such, these investigations, despite their restriction mostly to members of the benzene series and their regrettable lack of thoroughness as far as the other ring-systems are concerned, may be considered as a triumphant chapter in modern iatro-chemistry.

The comparative studies of the substituted as well as the unsubstituted β-phenyl-ethylamines, and β-phenyl-ethanolamines and their structural allies have brought to light many interesting generalisations. These have given an insight into the subtle ways in which physiological activity can be altered by even slight structural modifications of the sympathomimetics. In the present state of knowledge an answer to the interesting question of whether or not the same or similar rules governing the intimate relationship between constitution and activity of the benzenoid sympathomimetics operate in the case of their analogues derived from the higher polycyclics and the heterocyclics is, however, not yet possible. Another question which naturally arises, namely, whether the knowledge already gained can be applied for the rational evolution of future sympathomimetics possessing ring-systems other than benzene, must also for the present remain unanswered. This is in a large measure due on the one hand to the reason that sufficiently varied and comparable types of compounds belonging to the other ring-systems are not known and on the other, to the fact that, so far no systematic correlation has been attempted with even those compounds that have been available.

The gaps in existing knowledge must be finally bridged before the problem of the rational evolution of future sympathomimetics belonging to ring-systems other than benzene could be solved. Recent works in this line consist in attempts[26,45] to study systematically the synthesis and biological examination of groups of compounds derived from the carbo- and hetero-cyclics and which possess the requisite structures necessary for sympathomimetic activity.

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THE CHEMISTRY, PHARMACOLOGY AND THERAPEUTICS OF THE SULPHONAMIDES*

DR. V. R. KANOLKAR who presided over the symposium declared that the idea of using chemical substances for treating diseases is not new. The ancient Indian physicians employed oxides prepared from metals according to an elaborate ritual. Towards the commencement of the 16th century, Paracelsus advocated the use of chemical substances of known composition and his statement "All things are poison and nothing is without poison, but the dosage it is, which makes a thing poison" is worth reflecting upon even now. Physicians and pharmacologists have been searching for substances which would show a greater affinity for disease-producing micro-organisms than to the vital tissues of patients when introduced into the body. It was expected that substances which kill pure cultures of micro-organisms *in vitro* may as well disinfect the blood or other fluids when administered in non-toxic doses. It was soon discovered, however, that small doses of most bactericidal drugs were rendered inert by blood proteins before they can act on the micro-organisms. It is true that remedies have been empirically discovered for some parasitic diseases, such as quinine for malaria, emetine for amœbiasis and mercury for syphilis.

The modern methods of chemotherapy may be assumed to have started about 1895 with the use of cacodylates and atoxyl for combating parasitic infections. High hopes of a discovery of specific antiseptic remedies in the early years of this century were entertained when Ehrlich discovered considerable difference in the affinity of different tissues to certain synthetic dyes. Ehrlich and his pupils devoted many years of work in search of a "therapia sterilisans" and their efforts were attended with some success in the synthesis of an organic arsenical compound—salvarsan. Unfortunately most of the drugs synthesised during the first two decades of this century were ineffective against bacteria and viruses though they were potent against protozoa and spirochætes. The discovery by Domagk in 1935 of a synthetic azo dye which is a powerful agent in arresting the growth of micro-organisms in the tissues has opened up a new era of therapeutic progress. A large number of synthetic compounds have recently been prepared and their pharmacological properties studied in several countries. The progress has been phenomenal, and infections which were looked upon as uniformly fatal have been treated with remarkable success. These drugs have been tried experimentally in animals and clinically in patients in a large number of infective conditions during the last eight years. Their advantages and limitations have been carefully worked out. Their use in plague, a disease more or less endemic in India, has probably been the most important contribution in this field in our country. Before asking the main speakers to address you, I would like to say a few words about the chemotherapy of plague. The first thing to realise is, that all people who suffer from plague do not die of it. Usually about 50 per cent. survive an attack with almost any treatment. On the other hand, if a fair number of plague bacilli could be cultured from the blood (septicæmic plague) the probability of a fatal termination is certain in nine out of ten cases with most treatments. The efficacy of the sulpha drugs is, therefore, assessed only in septicæmic types of plague.

The use of these drugs is now being extended to the treatment of war wounds and surface inflammations where the drug can be applied in adequate concentration. Dr. Dikshit has prepared a paste which has found favour in the treatment of wounds, burns and tropical ulcers.

DR. K. GANAPATHI said that soon after Domagk's announcement of the therapeutic properties of prontosil, Fourneau and his collaborators made the important discovery that prontosil owed its activity to sulphanilamide produced *in vivo* by reduction. This greatly accelerated the speed of research and engaged a large group of investigators all over the world. The derivatives of sulphanilamide synthesised and studied in large number are mainly of two groups—those substituted at the amino radical and those with substituents at the sulphonamide radical. As a result of the studies, it emerges that only those compounds with a free amino group or in case the amino group is substituted those in which the compound with the free amino group is liberated *in vivo* by fission, show therapeutic activity; in recent years, compounds of this second group like succinylsulphathiazole, phthaloylsulphathiazole have been deliberately prepared to restrict the locus of action of these compounds and make them adaptable for the treatment of intestinal infections. A large number of compounds with various types of substituents at the sulphonamide radical of sulphanilamide have been studied of which the most promising are the heterocyclic derivatives. Starting from sulphapyridine, a rapid search for more active compounds among the heterocycles has presented us the potent drugs as sulphathiazole, sulphadiazine, sulphapyrazine and some of their derivatives. The ring systems known to the chemist and are amenable to the synthetic processes have been tried and most of the compounds obtained thus are either devoid of activity or greatly reduced in activity. Also, substitution of further atoms or radicals in the heterocyclic ring of sulphapyridine, sulphathiazole and sulphadiazine have been tried and the compounds have been found to be varied in activity. The results obtained appear *prima facie* to follow no law from the structural point of view; they lead to the conclusion that the attempts to link the therapeutic activity with a particular structure, picturing the various radicals or atoms to be contributing additively to the therapeutic property of the compound, will not lead us far. Rather it appears that the chemotherapeutic property is more systematically related to some fundamental physical or phy-

* Abstract of a symposium held on the 27th December at Poona under the joint auspices of the Indian Academy of Sciences, Bangalore, and the National Academy of Sciences, Allahabad.

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sico-chemical property of the compound. In the case of the sulphanilamides, wherein we have got a series of compounds of graded activities which differ in structure only in the nature of the substituent at the sulphonamide radical, the problem is only to discover the particular physical property of the compound (governed by the sulphonamide grouping) running parallel to the bacteriostatic activity. Bell and Roblin, concerning themselves with the N^1-substituted compounds, have succeeded in correlating the dissociation constant with the bacteriostatic action of the compounds against B. coli *in vitro* over a fairly wide range. These results are obtained on the basis of the theory (which is derived from Fildes-Woods concept of the mechanism of action of the sulphonamides) that the greater the negativity of the sulphone grouping in the compound, the greater the bacteriostatic activity. This negative nature of the sulphone group appears to be fundamentally related to the activity in some way as yet not perfectly understood and it holds good in spite of the theories of Fildes and Woods being seriously questioned. The problem now consists in quantitatively equating this with some measurable physical property, also among compounds which fall outside the scope of the Bell-Roblin theory.

Dr. B. B. Dikshit classified the sulphonamides into three main groups:—(*i*) those which are readily absorbed from the gastro-intestinal tract, (*ii*) those which are poorly absorbed and (*iii*) those which can be profitably used for local application, *e.g.*, to ulcers and wounds; this group consists of drugs of groups (*i*) and (*ii*). Important drugs belonging to the first group are sulphanilamide and its pyridine, thiazole and pyrimidine derivatives, the pharmacological actions of which are well known. Important drugs belonging to the second group are sulphaguanidine, succinylsulphathiazole and phthalylsulphathiazole. They are poorly absorbed from the gastro-intestinal tract and thus remain in the intestines producing a bacteriostatic action.

In this country intestinal infections like cholera, enteric fevers and dysenteries are more common than in America and European countries and, therefore, it is highly desirable that research workers should devote their attention towards drugs belonging to the second group mentioned above. From the pharmacological point of view the requirements of such drugs would be that they should not be readily absorbed, they should be soluble to a certain extent in the intestinal juices and they should have a bacteriostatic action on the pathogenic organisms in the intensities like those producing cholera and dysentery. My colleague, Dr. H. S. Mahal, working in my laboratory, has combined sulphonamides with several other known antiseptics with the view that in the intestines their combinations will split up and the individual drugs so liberated will be able to produce their antiseptic action on the intestinal flora. In such experiments if the splitting of the combinations is too rapid, absorption of the individual drugs will also be rapid and if the splitting is too slow, sufficient quantities of the drug to produce the bacteriostatic properties will not be liberated. An ideal drug will be such that it would produce a desired concentration in the intestines without undergoing rapid absorption. We have tried several such combinations but so far as we have not been able to find the ideal drug; we are, however, hopeful of obtaining good results.

The idea of combining antiseptics with sulphonamides, however, appears more promising in the treatment of wounds and ulcers. In fact, here, one need not restrict oneself to sulphonamides. Any combination of antiseptics which will gradually split up in the wound or ulcer could be useful. Such combinations if properly made would not be quickly absorbed from the site of application, would be less irritating and because of slow splitting will be able to exert a continuous antiseptic action. One such combination of proflavin and formalin made by Dr. Mahal has been found to be very useful in the treatment of Tropical ulcers. Because of small stock of the drug at our disposal we could not give it an extensive trial. I have referred to these experiments to draw the attention of research workers to this idea so that better and more powerful antiseptics may be found.

Dr. P. M. Wagle discussed the therapeutic value of the various sulphonamides in different bacterial infections. After the discovery of the remarkable therapeutic properties of sulphathiazole and sulphapyridine, in experimental plague infections in mice by Sokhey and Dikshit, clinical trials were given to these drugs. Later on sulphadiazine was also tried. These were done in plague epidemics in different parts of India and the results obtained have fulfilled the expectations of the animal experiments. On the whole, including the last trial at Poona, 996 cases have been treated systematically and under strictly controlled conditions. No selection of cases were made but treatment was given in strict rotation as they came. Bacteriological diagnosis was made in each case for plague by isolating the organism and also by determining the presence or absence of septicæmia. The concentration of the drug in the blood after its administration was determined every day in all cases; this was to check up the absorption of the drug and to control the dosage. The hæmoglobin estimation, leucocytic count and the differential count were made in all cases every alternate day to control the toxic reaction. Usual precautions in the treatment with the sulphonamides were taken. The concentration of the drugs in the blood aimed at and attained was 5-10 mg. per 100 c.c. of blood in the case of sulphapyridine and sulphathiazole and 10 to 15 mg. in the case of sulphadiazine. Concentrations higher than these were tried; they were not found to give better results but only proved to be more toxic. The actual dosages of the drugs which gave rise to the above-mentioned blood concentrations are as follows:—In the case of sulphapyridine, 2 gms. on admission, 2 gms. four hours later and then 1 gm. every four hours making a total of 8·0 gms. on the first day and then 0·5 to 0·7 gm. every four hours making up 3·0 to 4·5 gms. per day thereafter. In the case of sulphathiazole, 2·0 gms. on admission, 2·0 gms. after four hours and then 1·5 gms. every four hours making up a total of 10·0 gms. on the first day and then 1 gm. every four hours on the subsequent days with a total of 6·0 gms. per day. In the case

Treatment	All cases taken together			Septicaemic cases alone		
	No. of cases treated	No. of deaths	% case mortality	No. of cases treated	No. of deaths	% case mortality
Antiplague serum	157	37	23·5	71	36	50·7
Sulphapyridine	122	33	27·0	62	31	50·0
Sulphathiazole	305	64	20·9	132	55	41·6
Sulphathiazole + antiplague serum	60	12	20·0	25	8	32·0
Sulphadiazine	81	10	12·3	43	9	20·9
Controls (iodine intravenously) ..	149	80	53·6	75	68	91·0

of sulphadiazine, 2·0 gms. of the sodium salt was given intravenously and also 2·0 gms. of the drug was given by mouth on admission, 2·0 gms. after four hours and then 1 gm. every four hours with a total of 10·0 gms. on the first day and then 1 gm. every four hours on the subsequent days. The results obtained are given in the table. In this, 112 cases have been excluded as they were moribund on admission and the drug has not the chance to act on these drugs. In the table the results are given (*i*) taking all the cases and then, (*ii*) taking only the septicæmic cases and the significance of the results is obvious.

The results show that the sulphonamides possess very striking therapeutic activity against plague infection and have brought about a considerable reduction in mortality. Though the number of cases treated with sulphadiazine is not great as with others, there is a suggestion that it gives the best results. The toxic symptoms observed were as usually described but were less frequent possibly because the dosage and the blood concentrations have been carefully regulated. Sulphadiazine appears to be the least toxic.

Dr. V. L. Deshponde gave his experiences of treating plague at Poona before the advent of the sulphonamides and with sulphathiazole and sulphadiazine. The trial with the sulphonamides in plague in the recent epidemic was carried out in collaboration with Dr. P. M. Wagle. The use of the sulphonamide drugs, he said, has brought about a striking reduction in mortality. He dealt at length with many clinical details and observations he had made in his recent trials at Poona.

PHARMACY AND DRUG LEGISLATION IN INDIA

Two symposia, one on "Newer Pharmaceuticals" and the other on "Future Pharmacy and Drug Legislation in India", were among the proceedings of the Fifth All-India Pharmaceutical Conference held in Bombay under the presidentship of Dr. H. K. Sen during the 21st-23rd December 1944. The first of these covered a wide ground, illustrating some of the recent spectacular achievements of chemistry in its application to medicine. Foremost among these has been our knowledge of the synthetic drugs where development has been along three main lines:—(1) the reproduction, in the laboratory, of products obtained from nature, *e.g.*, adrenaline, the vitamins and hormones; (2) discovery of drugs equivalent to, or even better than, those obtained from natural sources, *e.g.*, atebrin, plasmoquine, stilboestrol; and (3) discovery of drugs of entirely new structures, *e.g.*, the sulphanilamides, aromatic amidines, etc. Dr. K. Ganapathi gave a comprehensive summary of these synthetics and dwelt at some length on the sulphanilamides which group has been steadily increasing to our advantage and which has testified to the ingenuity of the organic chemist who, in the words of the lecturer, "has very nearly exhausted the ring systems he can think of". Among the drugs of this group that have recently emerged out of his efforts are some highly potent ones in the treatment of many types of streptococcal, staphylococcal, gas gangrene and intestinal infections. One of these, marfanil, is not nullified in its therapeutic effect, by *p*-amino benzoic acid or pus or tissue decomposition products and is, in this respect, next only to penicillin. Compounds of similar groups are now being studied and offer great promise, particularly in the treatment of local infections where sulphanilamides are not ideal for use.

Dr. B. K. Nandi gave an account of the principal glandular products that have uptil now earned conspicuous reputation and have met with the clinician's approval. One wished that he had dwelt more on the scope for their manufacture from the slaughterhouse wastes in the country and the need for appropriate municipal and State aid for the proper collection of glands under conditions ideally suited for their subsequent processing.

In a paper on the vitamins, which evoked some interesting discussion, Dr. V. N. Patwardhan briefly surveyed the position which these occupy among the pharmaceuticals and indicated how, as a result of the enormous amount of work now in progress, vitamin therapy may, within the next few years, assume a much wider scope than at present. He, however, sounded a note of warning against the indiscriminate use, in the form of shotgun therapy, of the vitamins by the busy practitioner who is only faintly acquainted with the modern advances of vitamin research but is greatly influenced by the manufacturer who swamps him with pamphlets and reports under the respectable name of literature extolling the properties of his particular brand of vitamin preparation. Dealing with the scope and value of vitamins, vitamin concentrates and multivalent vitamin preparations in post-war relief programmes, he stressed on the

need for research on the synergetic or antagonistic action, as the case may be, of one vitamin on another. More information is obviously needed to put the practice of combining more than one vitamin in a single preparation on a sound theoretical basis.

LT.-COL. SOKHEY, who presided over these deliberations, correctly pointed out how manufactures in the country had not availed themselves of the opportunities afforded by the war and had resorted to mere compounding, mostly out of imported pharmaceuticals. Doubtless, there are difficulties in the way of the development of a synthetic drug industry in the country, chief among them being, as mentioned by Dr. R. D. Desai, the need for dependence on foreign imports for a variety of intermediates which cannot be manufactured in the country until the heavy chemical and coal-tar industries get securely established. In this connection, an aspect of drug production that came for little discussion related to bio-synthesis from agricultural and industrial waste products. A host of substances of therapeutic value, like lactic, citric and gluconic acids, food yeast and antibiotic mould metabolites could well be prepared by fermentation processes without dependence upon imported intermediates.

There was unanimity underlying the discussions on the second symposium on the future of pharmacy in the country. The speakers stressed on the need for (1) control of pharmaceutical practice by limiting it to a properly qualified group of people as in most parts of the world, and (2) a uniform central legislation for drugs and pharmacy combined. In opening the discussion, DR. B. MUKERJI referred to the present deplorable position of the profession of pharmacy in India and emphasized how there can be no practice of pharmacy without the aid of medicine and how both the professions should, therefore, work hand in hand and strive together to achieve the goal of a higher standard of national health and fitness.

DR. R. R. NANJI gave a brief review of the growth and development of pharmaceutical education in England and other countries abroad and showed how India was probably a century behind most civilised countries in this respect. He also outlined certain legislative measures aiming at improvements in the standard of training and qualifications of pharmacists and suggested the creation of a Central Pharmacy Board for the general control of the profession.

The Central Government have recently enacted a Drug Act, 1940, and are shortly proposing to enact Drug Rules under this Act, which take cognisance of the urgent needs of the country outlined above. These are happy augeries, for, statutory control over what is at present only a chaotic situation is bound to raise the status and prestige of Indian Pharmacy and bring in its wake a better economic position for the pharmacist and a lasting recognition as an active partner of the noble public health profession. A detailed account of the proceedings of the Conference will appear as a Special Number of the *Indian Journal of Pharmacy*.

A. SREENIVASAN.

SUBSTANTIVITY OF DYES IN RELATION TO CHEMICAL CONSTITUTION*

SUBSTANTIVITY is not an absolute property and it is difficult to define. There is no sharp demarcation between substantive and unsubstantive dyes. All direct dyes tend to form colloidal solutions. Particles in molecular solution diffuse through the fibre and do not function in the dyeing process, unless there is a change in their state of aggregation due to an alteration in conditions.

There are a few natural colouring matters (bixin, carthamin, curcumin), which are substantive to cotton, and which do not contain nitrogen or sulphur; but the synthetic direct cotton colours are the sodium salts of aromatic sulphonic acids containing nitrogenous groups. Cotton takes up these dyes in the form of neutral sulphonates. Further, marked substantivity to cotton is shown by the leuco compounds of sulphur dyes and of the anthraquinonoid vat dyes, including those not containing nitrogen and sulphur, and the arylamides of hydroxynaphthoic acid.

The structural features favourable to substantivity in azo dyes are now well recognised. Following Schirm's hypothesis of conjugated unsaturation, Hodgson has postulated a coplanar configuration of the aromatic nuclei as a necessary condition for the production of substantivity. Coplanarity in a dye molecule is an advantage for attachment to the cellulose chain, but there are at least two recorded instances of non-coplanar dyes with substantivity for cotton. Sen and Sadasivam noticed that the dye from tetrazotised 2:2′-di-hydroxymethyl-benzidine and β-naphthol-6-sulphonic acid was substantive. The significant factor here is probably the hydroxyl in each of the groups in the 2:2′-positions; the hydroxyls could anchor themselves by hydrogen bonding to the glycosidic oxygens in suitably situated chains of the cellulose macro-molecule, so that a complicated, but easily conceivable, molecular network between dye and cellulose develops. The second example is a new class of substantive azo dyes described by Allen and Pingert (1944), which are derived from 4:4′-diamino-*o*-terphenyl and which cannot be coplanar.

Among similar groups of dyes, the substantivity increases from the benzene to the naphthalene, anthracene and the more complex, condensed polynuclear aromatic hydrocarbon series. This is not due to the mere increase in molecular weight, but the special characteristics of the valence-bond structures are involved. The leuco compounds of the anthraquinonoid vat colours as a class are characterised by high substantivity. The leuco compounds, for instance, of dibenzanthrone, its 16:17-dimethoxy derivative and isodibenzanthrone are very highly substantive; and the complete absence of nitrogen and sulphur, invariable constituents of the direct cotton colours, will be noticed. The alkaline solutions of the reduc-

* Abstract of Dr. K. Venkatraman's Presidential Address to the Section of Chemistry, Indian Science Congress, Nagpur, 1945.

tion products (or 'vats') of some of the anthraquinone vat dyes have such high affinity for cotton, and the baths are so rapidly exhausted, that the dyeing process has to be retarded and controlled by the addition of restraining and level dyeing agents, consisting of glue or synthetic protective colloids.

The substantivity of the anthraquinonoid vats is associated with the resonance among numerous valence-bond structures by which the higher condensed ring systems can be represented. The angular ring systems have a larger number of stable resonating structures and a larger resonance energy than the corresponding linear ring systems. Angular configuration of condensed ring systems is a common feature of anthraquinone vat dyes. Among the isomeric dihydro-anthraquinone-azines, the commercial product which possesses the substantivity necessary for practical dyeing is indanthrone, having the *bis*-angular orientation. Other examples are the *bis*-acridone, Indanthrene Violet BN and the tetracarbazole, Indanthrene Khaki GG. The more complex the polynuclear system and the greater the number of benzene rings, the larger will be the resonance energy. One effect of resonance will be coplanar configuration of the molecules. It would appear that there is a broad correlation between the number of stable resonance forms and the resonance energy on the one hand, and the substantivity on the other, of the leuco compounds of anthraquinone vat dyes.

The older conceptions of substantive dyes as those possessing long thread-like molecules of approximately straight line form, which were based on the benzidine type of azo dyes, must be modified in view of the constitution of the highly substantive leuco compounds of the anthraquinone vat dyes. The affinity of a complex polynuclear dye such as Indanthrene Khaki GG probably involves the attachment of the dye molecules to several parallel cellulose units at suitable points, so that the dye molecules act as bridges or grids in a three-dimensional network.

While the indigoid and thioindigoid vats are yellow, the anthraquinone vat dyes give intensely coloured vats; Indanthrene Yellow G thus gives a deep blue vat. Alkaline reduction of an anthraquinone vat dye produces auxochromic hydroxyl groups which introduce much greater possibilities of resonance than in the case of leuco-indigoids, on account of the large number of aromatic ring systems. Bathochromic effect and substantivity do not always go together, but there seems to be enough evidence to believe that the resonance factors favourable for intense colour are also favourable for substantivity in the anthraquinone vats, the requirements regarding the degree of dispersity in aqueous solution being satisfied.

The conversion of the leuco-forms of vat dyes to the sulphuric esters, the sodium salts of which are marketed as Indigosols and Soledons, greatly reduces the substantivity. The Soledon has a much lower substantivity than the alkaline vat. The reduction in substantivity may be correlated with the change in the colloidal and electrochemical character of the solution, as well as the restraining influence of the sulphonic group on the resonance of the molecule. Among the Indigosols and Soledons, the anthraquinone derivatives have in general higher substantivity than the indigo and thioindigo derivatives, and in the former group the substantivities run roughly parallel with those of the vats of the parent-dyes.

Schirm has attributed the substantivity of Naphtol AS to conjugation due to enolisation of the -CONH- group, but the constitutional factor fundamental to the substantivity of the naphthols is the hydroxyl adjacent to the -CONH- group, and this must play a part in the attachment to cellulose. Among the facts to be borne in mind in considering the structural forms of the "naphthols" are the substantivity in alkaline solution with consequent ionisation and the speed with which the "naphthols" couple even with very weekly polarised diazo salts, indicating the anionoid character of the *l*-carbon atom. Several valence-bond structures may then be suggested as the predominating resonance forms. The essentiality of the 2-hydroxy-3-carboxyamide grouping and the nonsubstantivity of the isomers are probably concerned with steric factors governing the attachment of the reactive centres in the naphthol to the cellulose chain. Such steric factors are apparently also involved in the greater substantivity of the β-naphthylamide of hydroxynaphthoic acid in comparison with the α-isomer. The increase in substantivity by replacing the naphthalene nucleus in the acid half or the benzene nucleus in the amine half of the Naphtol AS molecule by more complex and condensed ring systems is related to the resonance among more numerous valence-bond structures and the larger resonance energy.

The constitutional factors which are favourable to the substantivity of dyes towards cellulose are summarised as (*a*) conjugated unsaturation; (*b*) coplanarity of the ring systems; (*c*) condensed ring systems, representing a large number of resonating forms and high resonance energy; (*d*) heterocyclic nuclei; (*e*) specific atoms and groups in suitable positions; (*f*) dipole characteristics; polar groups of opposite character connected by a conjugated system, leading to a large amplitude of resonance and a large polarisability; (*g*) colloidal character in aqueous solution, and a balance between the hydrophobic and hydrophilic parts of the molecule.

Measurement of interatomic distances between the reactive centres in dye molecules in their stable resonance forms, and their relation to the interatomic distances between the reactive centres in the cellulose chain, might ultimately give us a picture of the mode of attachment of dyes to cellulose. Since the cellulose macromolecule contains a very large number of both electron-donor oxygen atoms and electron-acceptor hydroxylic hydrogens, the affinity of cellulose for dyes with high molecular resonance structures, having a large amplitude of resonance and a large polarisability, is not difficult to visualise in general terms. Hydrogen bonding readily suggests itself as the likely mechanism of the intermolecular dye-cellulose attachment in view of the strength of the linkage and the rapidity of dyeing processes. However, there is a long way yet to go before complete theories of the colour of dyes and of their varying degrees of affinity for cellulose can be developed. The constitution of the whole series of substantive dyes must be studied in conjunction with the present view of the structure of cellulose as a network of discrete, crystalline micelles together with amorphous regions of disorderly orientation.

LETTERS TO THE EDITOR

FAMILIAL CORRELATIONS OR THE MULTIVARIATE GENERALISATIONS OF THE INTRACLASS CORRELATION

THE characters of individuals in a family or a group are influenced by two types of factors (*i*) the common factors which are characteristic of the group and (*ii*) the random factors which are independent of the group. The former type causes resemblance among the individuals of a group, while the latter brings about their variation. One of the problems, in the study of heredity, is to measure the strength of group characteristics. If we assume that there are a finite number of group factors effecting the characters of the individuals in a group, then suitable measures may be obtained by studying only a few characters for the individuals in a group. In this note, familial correlations, obtained by the multivariate generalisation of the intraclass correlation, have been introduced as suitable measures of the strength of group characteristics and their sampling distributions have been obtained.

2. Let x_{ijm} $(i = 1, 2, \ldots n;\ j = 1, 2, \ldots k;\ m = 1, 2, \ldots p)$ represent the observation on the m-th character of the j-th individual in the i-th family. Following Fisher's technique, we replace the observations on the p characters of an individual by their linear combination and choose the compounding coefficients so as to maximise the intraclass correlation coefficient. If we maximise the function $t^2 = [1 + (k-1)r]/[1-r]$ instead of r, we get t as a root of the determinental equation.

$$| b_{rs} - t^2 w_{rs} | = 0 \qquad (2\cdot1)$$

where $b_{rs} = \sum_j k\ (\bar{x}_{i\cdot r} - \bar{x}_{\cdot\cdot r})\ (\bar{x}_{i\cdot s} - \bar{x}_{\cdot\cdot s})$

$$w_{rs} = \sum_i \sum_j (x_{ijr} - \bar{x}_{i\cdot r})(\bar{x}_{ijs} - \bar{x}_{i\cdot s})$$

and $k\,\bar{x}_{i\cdot r} = \sum_j x_{ijr}$, etc.

There are, in general, p roots $t_1, t_2, \ldots t_p$ for the determined equation giving rise to p correlations $r_1, r_2, \ldots r_p$ which may be called the *familial correlations*. The following results have been obtained.

(*a*) The familial correlations are invariant under linear transformations of the variates.

(*b*) There exist familial correlations $\rho_1, \rho_2, \ldots \rho_p$, which are constants of the population obtained by employing the above principle to the population at large.

(*c*) The joint distribution of the familial correlations $r_1, r_2 \ldots r_p$, obtained from samples tends to the p variate independent normal distribution with

$$\mathrm{E}\,(r_i) = \rho_i \text{ and}$$

$$\mathrm{V}\,(r_i) = (1 - \rho_i)(1 + \overline{k - 1}\rho_i) / \sqrt{\tfrac{1}{2}nk\,(k-1)}$$

when the size of the sample (n) is increased.

(*d*) To carry on suitable large-sample tests the following transformations are suggested. Instead of r_i, we construct the statistic

$$z_i = \tfrac{1}{2} \log \frac{1 + \overline{k - 1}\, r_i}{1 - r_i}$$

whose variance being $k/2\ (k-1)(n-2)$ is independent of ρ_i.

(*e*) To test whether the familial correlations are simultaneously zero we use the statistic $\Sigma\, z_i^2/\mathrm{V}\,(z_i)$ which is distributed as χ^2 with p degrees of freedom in large samples.

(*f*) The exact sampling distribution of $t_1^2, t_2^2 \ldots t_p^2$ on the non-null hypothesis involves only $\tau_1, \tau_2, \ldots \tau_p$ defined by

$$\tau_i = \frac{1 + (k-1)\rho_i}{1 - \rho_i} \qquad (2\cdot2)$$

and is given by

$$\text{const. A} \prod_{i,j=1}^{p} \frac{c_{ij}}{(\tau_i^2 + t_j^2)^{\frac{1}{2}}} \prod_{j=1}^{p} t_j^{n-p-1} \prod_{i=1}^{p} dt_i \qquad (2\cdot3)$$

$$\times \left| \prod_{i<j} (t_i^2 - t_j^2) \right|$$

where A $\left[\sum_{i,\ j=1}^{p} \frac{D_{1j}^2}{(\tau_i^2 + t_j^2)}\right]^{\frac{nk-p-2}{2}}$

and D_{1j} is the coefficient of $c_{1j}/(\tau_1^2 + t_j^2)^{\frac{1}{2}}$ in the determinent $|\, c_{ij}/(\tau_i^2 + t_j^2)^{\frac{1}{2}} \,|$ and c_{ij}'s are defined as

$$\overset{2m}{c_{ij}} = 0, \quad \overset{2m+1}{c_{ij}} = 2^{\frac{2m+1}{2}}\, \Gamma\left(\frac{2m+1}{2}\right)$$

$$\overset{2m+1}{c_{ij}}\ \overset{2n+1}{c_{i'j'}} = 2^{\frac{m+n+1}{2}}\, \Gamma\left(\frac{2m+1}{2}\right) \times \Gamma\left(\frac{2n+1}{2}\right)$$

where $i \neq i'$ and $j \neq j'$

These substitutions are to be made only after expanding out A and multiplying it with other factor in (2.3). The distribution of r_1, r_2, ... r_p are obtained from (2.3) by making the transformations

$$t_i^2 = \frac{1 + (k-1)\,r}{1 - r_i} \quad (i = 1, 2, \ldots p) \qquad (2\cdot4)$$

(3) It is interesting to observe that the distribution (2.3) is similar to the distribution of the p-statistics of Roy (1942) on the non-null hypothesis. A fuller discussion of this subject will be attempted in a paper to be published in *Sankhya* shortly.

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November 18, 1944. C. RADHA KRISHNA RAO.

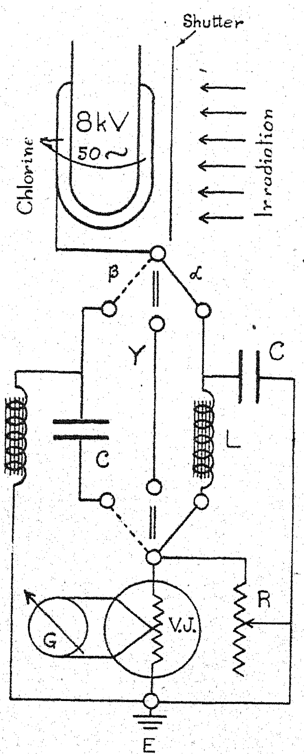
1. Roy, S. N., *Sankhyā*, 1942, **6**, 16–34.

THE PREFERENTIAL INCIDENCE OF THE *LIGHT-EFFECT* IN THE HIGH FREQUENCY REGION OF THE DISCHARGE CURRENT

THE apparent variation of the light-effect Δi, with the *mode* of the measurement of the discharge current i, was noticed soon after the discovery of this phenomenon.[1] Thus, *e.g.*, when i was observed with some *soft* diodes, the light-effect was negligibly small; using triodes, tetrodes, pentodes as also certain metal oxide type rectifiers, the proportionate effect $\%\Delta i$, *i.e.*, the current decrease under light expressed as a percentage of i in the dark, was marked but variable. Usually, $\%\Delta i$ was greater with a vacuo-junction than an oxide type A.C. indicator.[1] This was traced to limitations in the latter's efficiency of rectification observed *inter alia* under certain conditions of the container surface exposed to the discharge;[1] n, the frequency of the A.C. supply; and especially the strength and the range of frequencies generated under the discharge; these last are the chief determinant of Δi.[2,3,4]

Fig. 1 shows th main apparatus used for a study of the distribution of light-effect amongst H.F. and L.F., the high and low frequency components of i. This enters the vacuo-junction (*V. J.*, Fig. 1) *via* α, β or γ. In α, the iron core inductance L admits preferentially L.F. and inhibits H.F.; the latter are bypassed by the capacity C which comparatively impedes *L.F.* Similarly, β filters out L.F. and

Fig. 1



admits H.F. In γ, i consists of both the L.F. and H.F. characteristic of the discharge.

Table I shows a typical set of results. The ozoniser (Fig. 1) filled with chlorine was excited at V = 8 kilo-volts and 50 cycles frequency. The net effect Δi is largest for i, the

TABLE I

R (ohms)	Circuit	i in dark	i in light	Δi	$\%\Delta i$
300	α L.F.	2·0	1·23	0·77	39
	β H.F.	5·57	3·16	2·41	43
	γ H.F.+L.F.	6·78	3·88	2·90	43
1000	α L.F.	4·58	2·65	1·93	42
	β H.F.	12·7	6·9	5 8	46
	γ H.F.+L.F.	16·4	8·7	7·7	47

unfiltered, *i.e.*, the total discharge current; Δi is sensibly greater for the high than low frequencies. The presence of these frequencies, in addition to n, and the instantaneous diminution on irradiation of their amplitudes, was observed in the oscillographic studies of this phenomenon.[2,3,4] From the amplitude-changes in the oscillograms, Δi appeared

greater the higher the (output) frequency; the proportionate effect $\%\Delta i$ was similar at all the frequencies.[3,4] Subsequent work with different types of discharge and of the A.C. detector has shown that (*a*) both Δi and $\%\Delta i$ predominate in the H.F.

The decrease of the above quantities by decreasing V the applied potential is observed over a fairly wide range of conditions.[1,5,7,8] Furthermore, Δi depends upon $V-V_m$,[3,4] where V_m is the threshold potential required to initiate a discharge; V_m diminishes by increasing n.[3] From this it follows that a larger n would correspond to a lower V, and therefore, to a reduced light-effect which is actually observed.[3] This combined with (*a*) suggests that, *ceteris paribus*, the proportion of H.F. in i would increase by increasing V; this is to be expected also on general grounds. That V is more important than i, in the present phenomenon, is indicated by its non-observance below V_m[3]; secondary ionisation would appear to be a necessary condition.[3] It is to be anticipated, therefore, that despite a large i obtained, *e.g.*, with a high frequency n input to the system, the light-effect would not occur at less than the corresponding V_m. The (preliminary) experimental results are in accord with this deduction.

Chemistry Department,
Benares Hindu University,
November 19, 1944. S. S. Joshi.

1. Joshi, *Presidential Address*, *Chem. Sec.*, *Ind. Sci. Cong.*, 1943. 2 —, *B.H.U. Journ.*, 1943, **8**, 99. 3. —, *Nature*, 1944, **154**, 147. 4. — *Curr. Sci.*, 1944, **13**, 253. 5. —, and Deo, *Nature*, 1944, **153**, 434. 6. —, *Trans. Farad. Soc.*, 1927, **23**, 227. 7. —, and Deo, *Curr. Sci.*, 1943, **11**, 306. 8. —, —, *Nature*, 1943, **151**, 561.

A SCIENTIFIC NEW YEAR'S DAY

January 1st has struck me, for a long time now, to be the most appropriate day for beginning the year from the scientific or astronomical point of view. This is the time when the earth in its yearly revolution round the Sun in a slightly elliptic path, passes through the perihelion of its orbit and is thus nearest to its progenitor and the giver and sustainer of all life on it.

Any day may be chosen to start the year but there are some which can be said to have a preference over others for this purpose on account of their *quasi*-uniqueness. These are the days of the equinox or of the solstice. But these days go in pairs and, therefore, there is no absolute uniqueness about them. The time when the earth is in perihelion is unique. There is another time which is also unique, namely, when the earth is in aphelion. But it seems more appropriate to consider the time when the earth is nearest the Sun as the suitable time for the beginning of its revolution than when it is farthest away.

Many people consider that the spring equinox day, *i.e.*, March 21st, would have been a more appropriate day for beginning the year for it is about then that new life for the year may be said to begin. But this day (or any other day or any other reason) has not the universality that January 1st possesses on account of the earth being in perihelion at about this time. For, if March 21st is spring equinox for the northern hemisphere it is the autumn equinox for the southern hemisphere. Similarly the days of the solstices have the same kind of duality and non-universality.

The Hindu New Year Day, whichever it may be, the 1st of *Chaitra* on the Lunar reckoning or the 1st of *Vaisakh* on the Solar, is regarded, of course, by the Hindus as the most appropriate day for beginning the civil year on account of its being round about the spring equinox. But these days are open to the same criticism as above.

If we compare the year with the life of an individual, life begins from small beginnings, grows to maturity and then decays. Life does not begin with even partial maturity. Similarly days begin to grow longer about the 1st January (really on the 23rd December), become longest in June, and gradually dwindle to the smallest on the 22nd December. But this again has a local taint inasmuch as it applies only to the northern hemisphere.

It is perhaps true that when fixing January 1st as the New Year's Day, no reasons of the type mentioned above were taken into account but the day was fixed perhaps on purely religious grounds. However, it must be admitted that it was a very good choice.

It may be mentioned that the time when the earth is in perihelion (or aphelion) is not quite regular. In the first place, the *Nautical Almanac* abandoned from 1927 the practice of giving the hour of the day in this connection as it is given for the equinoxes and solstices. Before then the hour in connection with perihelion and aphelion and even the minutes in connection with the equinoxes and solstices were also given.

In the second place, the day when the earth is in perihelion varies from year to year between January 1st and January 4th, but is never earlier than January 1st. The *Nautical Almanac* of 1921 (*N.A.*'s from 1914 only are available locally) gives the time of the earth in perihelion to be December 31, 1920, 16 hours. But uptil 1926 the astronomers began their day at noon instead of, like the civil day, at midnight. According to civil reckoning, astronomer's day, December 31, 1920, 16 hours, becomes January 1, 1921, 4 a.m., and thus the anomaly of having two "perihelion days" in the same year, 1920, disappears. This year, 1945, the perihelion day fell on the 1st January as it did eight years ago, in 1937 and previous to that in 1929 and 1921. This eight-year period, however, is merely fortuitous, for prior to 1921, the earth was in perihelion on January 1st in 1918.

Hence January 1st stands out to have a scientific basis, a uniqueness and a universality with which to start the New Year and which is not possessed by any other day.

Physics Laboratory,
Government College,
Lahore, J. B. Seth.
January 8, 1945.

ULTRA-VIOLET BAND SYSTEMS OF THE HgI MOLECULE

In continuation of our recent work on the band systems of the diatomic molecules HgCl[1] and HgBr,[2] a reinvestigation has been made to systematise the analysis and interpretation of the known ultra-violet band systems of HgI. Emission bands in the two regions between λ 3100-λ2800 and between λ 2800-λ2650 designated as systems C and D by Wieland,[3] have been measured and analysed. They form the two components of a $^2\pi \rightarrow {}^2\Sigma$ electronic transition with the common final $^2\Sigma$ state. The (0,0) bands of the two systems are at ν 32785 and 36295 respectively. The first of these values agrees with that obtained by Wieland, but the second indicates, according to the newly obtained analysis, a shift of the system origin by about 160 cm.$^{-1}$ towards the violet from that suggested by Wieland[4] as a result of his experiments on the flourescence of HgI. The interval between the components is found as 3510, which is in conformity with the corresponding values of 3934 and 3889 obtained for HgF[5] and HgCl[1] band systems.

The following vibrational constants are determined for the D system obtained in emission

$$\nu_e = 36269{\cdot}2 \quad \omega_e' = 178{\cdot}0 \quad x_e'\omega_e' = 1{\cdot}14$$
$$\omega_e'' = 125{\cdot}7 \quad x_e''\omega_e'' = 1{\cdot}10$$

Full details of the analysis will be published elsewhere.

Andhra University, Guntur,
January 18, 1945.
K. R. Rao.
M. G. Sastry.
V. G. Krishnamurty.

1. Rao, K. R. and Ramachandra Rao, *Current Science*, **1944, 13,** 279. 2. —, *Ibid.* (in press). 3. Wieland, *Helv. Phy. Acta.*, **1929, 2,** 46. 4 —, *Zeits. f. Phys.*, **1932, 76,** 801. 5. Howell, *Proc. Roy. Soc.* (Lond.), 1943, **A182, 95.**

OESTROGEN POTENCY OF THE DEFATTED CASTOR-SEED

It was shown[1] that the œstrogens of the ovary are in combination with a protein and that the complex exhibits feeble lypolytic activity. It was thought of interest to investigate other lipases also. This note deals with the castor seed lipase.

Castor-seeds (*Ricinus communis* Linn.) crushed, and defatted by ether and further powdered to a 40-mesh, was found to possess hypolytic activity (13·4 c.c. of 0·1 N alkali for 0·2 gm. of the material, when tested on olive oil substrate). The material after digestion with papain at 40° C. (pH 5·0) for 20 hours, with a view to liberate the active principles from the protein complex, was saturated with NaCl and thoroughly extracted with ether. Ether is removed by evaporation and the oily residue taken up by olive oil and the solution employed for biological assay.

A group of ten ovariectomised female rats was used. 0·3 c.c. of olive oil solution was injected in each of the ten rats subcutaneously. A few rats were injected with 0·3 c.c. of castor oil to see whether castor-oil has any œstrogen potency. In eight out of the ten nucleated cells and cornification was observed. The number of leucocytes in the smears was considerably reduced although in no case it was found to disappear completely. Castor oil, however, fails to induce any response.

Thanks are due to Dr. B. K. Bhattacharya for his kind help and to Professor V. Subrahmanyan and Dr. N. N. De for their keen interest.

Dept. of Biochemistry,
Indian Institute of Science,
Bangalore,
December 9, 1944.
M. B. Sahasrabudhe.

1. *Curr. Sci.*, 1945, **14,** 43.

THE CUPRIC-AMMINO SULPHATES

The cupric-ammino sulphates have been studied by a large number of workers. A Bouzat[1] has reported the existence of the penta-, tetra-, and bi-ammino compounds, and he has given the methods of isolation of these. Other workers, H. Rose,[2] D. I. Mendeleef,[3] W. R. Hodgkinson and C. C. Trench,[4] and F. Ephraim,[5] have studied the ammino compounds by various methods.

An attempt has been made in this laboratory to study the cupric ammino sulphates. The method employed consisted in the electrical conductivity measurements of solutions of cupric sulphate, of varying concentrations of ammonium hydroxide, and also of mixtures of the cupric sulphate with varying concentrations of ammonia. It was found that the mixture was much more conducting than either constituent, and the conductivity values were even greater than the sum of the conductivities of the constituents. In a graph the percentage difference between the sum of the conductivities of the constituents and the observed conductivity of the mixture was plotted against the concentration of ammonia. The graph gave a periodic curve with maxima points corresponding to 2 NH_3, $4NH_3$, 5 NH_3 and $6NH_3$ for a molecule of $CuSO_4$; showing the existence of bi-, tetra-, penta, and hexa-ammino compounds of cupric sulphate. Thus we observe that the conductivity data not only support the existence of the well-known ammines, but also give the evidence of the existence of a new ammino compound, *viz.*, hexa-ammino cupric sulphate which was previously unknown, and has for the first time been recognised in this investigation. Detailed procedure of the study of the hexamine compound will be duly communicated.

The authors offer heartfelt thanks to Dr. S. Ghosh for his kind interest in this work.

A. K. Bhattacharya.
Arun K. Dey.
Chemical Research Laboratory,
Allahabad University,
December 30, 1944.

1. Bouzat, A., *Ann. Chem. Phys.*, **1903, (7), 29,** 372. *Compt. Rend.*, 1902, **134, 1218.** 2. Rose, H., *Pogg. Ann.* **1830, 20,** 150. 3. Mendeleef, D. I., *Ber.*, **1870. 3,** 422 4. Hodgkinson, W. R., and Trench, C. C., *Chem. News*, **1892, 66, 223.** 5. Ephraim, F., *Ber.*, **1919, 55, 940.**

A PRELIMINARY NOTE ON THE STUDY OF COMPLEX FORMATION BETWEEN STANNIC CHLORIDE AND DIBASIC CARBOXYLIC ACIDS

F. W. Clarke[1] has observed that the precipitation of stannic sulphide, from solutions of stannic chloride, is hindered by the presence of oxalic acid. Rössing[2] has utilised this fact in separating tin and antimony, by adding oxalic acid to a solution containing a mixture of salts of these, and then passing hydrogen sulphide, when tin remains in solution, and antimony alone is precipitated as sulphide. No definite information is, however, on record as to the cause of the inhibition. The present study has been taken up to investigate the real mechanism and the extent of the inhibition brought about by oxalic acid and other di-basic acids of the group, *viz.*, carbonic, malonic and succinic acids.

Carbonic acid $\begin{array}{l} C\cdot OOH \\ | \\ OH \end{array}$, the first member of the series and its salt were both unable to act as inhibitors.

It was found that oxalic acid when present in small quantities, had no effect on the precipitation of tin sulphide and it was not until 7 c.c. of N/2 oxalic acid were added to 5 c.c. of M/20 stannic chloride solution that inhibition seemed to commence. With greater amounts of oxalic acid, the precipitate grew gelatinous in nature and became a deep brown gel. Finally when to 5 c.c. of M/20 stannic chloride solution, 10 c.c. of N/2 oxalic acid were added, it became colloidal in nature and exhibited a green fluorescence. There was no point of total inhibition, because on passing sulphuretted hydrogen for a long time or on leaving overnight the colloid jellified and finally settled completely.

Potassium oxalate was found to be a more effcient inhibitor; 7 c.c. of N/2 potassium oxalate were required for 5 c.c. of M/20 stannic chloride as compared to 10 c.c. of oxalic acid.

Malonic acid $CH_2\begin{array}{l} \diagup COOH \\ \diagdown COOH \end{array}$, the next higher acid was tried, and a far larger quantity was needed for 5 c.c. of M/20 stannic chloride; sodium malonate was a bit more efficient than the acid.

Succinic acid $\begin{array}{l} CH_2\cdot COOH \\ | \\ CH_2\cdot COOH \end{array}$ was unable to inhibit, though sodium salt was found to have a slight effect.

It is suggested that the inhibition is due to a complex formation between stannic chloride and the acid or salt. Electrical conductivity measurements and absorption spectra studies were also found to support complex formation.

Further work, to elucidate the composition and structure of the complexes, is in progress.

Chemical Research Laboratory,
Allahabad University, Arun K. Dey.
December 20, 1944. A. K. Bhattacharya.

1. Clarke, *Chem. News* **21**, 124. 2, Rössing, *Zeit. anal. chem.*, **41**, 1.

BIOLOGICAL ESTIMATION OF ADRENALINE IN GUINEAPIGS

Biological assay of Adrenalin solutions is generally carried out on spinal cats according to the method of Elliot. The method is reasonably accurate, and more convenient than the rabbits' intestine method which, though more sensitive, is not adaptable for routine assays. Great difficulty is being experienced in procuring suitable cats; assay trials have revealed that guineapigs could conveniently be used for standardising adrenaline solutions easily available and the method reasonably accurate.

Healthy male or female guineapigs fasting 24 hours and weighing between 500-750 gms. were anæsthetised by intra-peritonial injection of urethane (1·5 gm. per kg.). Prior to the administration of the anæsthetic the animals were injected subcutaneously with 0·75 mg. per kg. of atropine. The animals were generally ready in 1 to 1½ hour for dissection. If necessary, small quantities of ether were carefully administered. Tracheotomy was done, a fine glass tracheal cannula (prepared in the laboratory) was inserted, tied, and then connected to the artificial respiration pump. Both the external jugular veins were then dissected out, and a venous cannula inserted into one of them. Thereafter the internal carotid artery on both sides was separated very carefully from the vein and the vagus nerve, and ligated at the cerebral end. A fine arterial cannula (prepared and suitably grinded in the laboratory) was then inserted into one of the arteries and connected to the mercury manometer. This part of the operation requires to be done very carefully but provided sufficient care is taken in the selection of the cannula and attaining steadiness of the hands, is not difficult. Occlusion of the artery should be done by traction with a fine thread instead of an artery clip, however small it may be. Rise of blood pressure in guineapig is fairly high at the outset but gradually falls to a level of 25-40 mm. of Hg in about half an hour, when the animal is ready for assay.

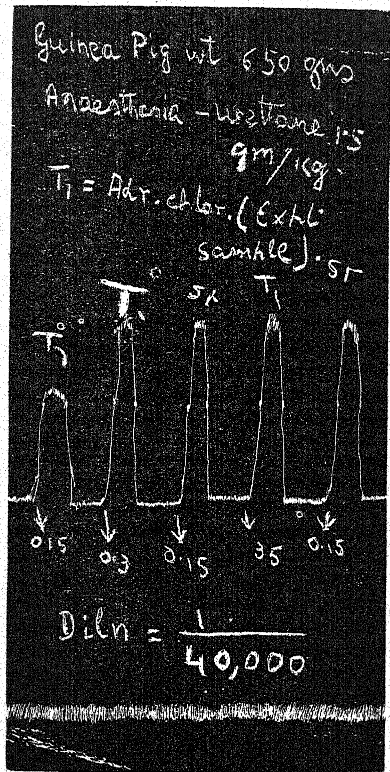
Certain precautions should be taken during the preparation of the animal. The operating table should be so raised as to be on a fairly same level with the mercury manometer; otherwise sodium citrate may be sucked into the heart owing to a great difference of pressure and cause the heart to fail. Excursion of the lungs should be carefully regulated by controlling previously the volume of air in the respiration pump. A complete fast of 24 hours is essential for proper anæsthesia; otherwise the animals frequently become resistant.

0·1 c.c. of a 1/40,000 dilution gives a fair and rapid rise in blood pressure (30-40 mm. of Hg). The time of rise and fall is almost the same as in spinal cats. We generally assay the test solution in strength of 1/40,000 and the doses are varied from 0·1-0·3 c.c. Infusion of saline given with each test solution is 0·5 c.c. Tachy-phylaxis sometimes occurs, specially if the intervals between the injections are shortened, or a very large number of injections are given.

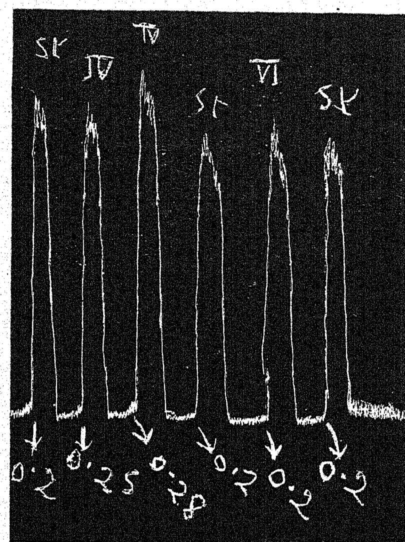
ration, or the period of testing. Chloroform and ether anæsthesia was found to be unsuitable for the purpose.

Preliminary atropinisation of the animal is very helpful in preventing vagal inhibitions during rise in blood pressure, and tended to maintain a fairly constant level.

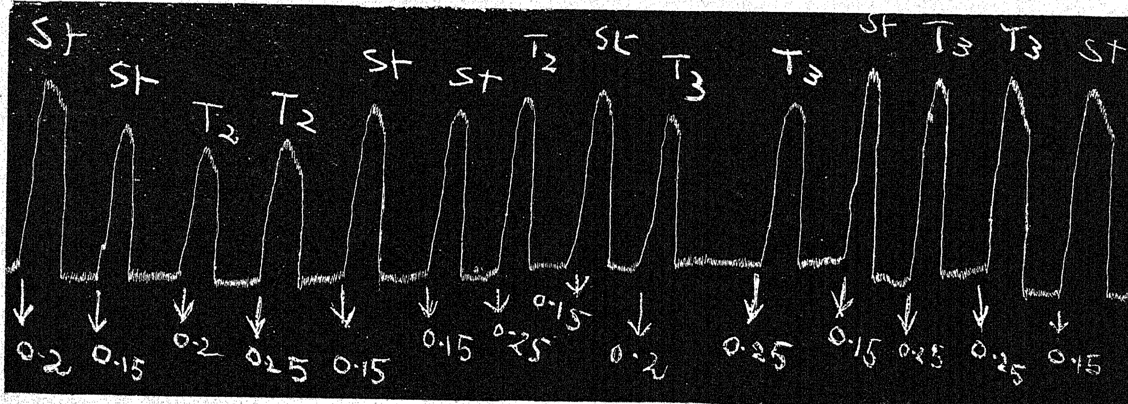
Accuracy of the method.—Solutions of adrenaline could be standardised by this method with an accuracy of ± 4-10 per cent. The



CURVE I



CURVE II



CURVE III

Curves I, II & III show the response to 1 in 40,000 dilution of Adrenaline

Adult guineapigs are found to be somewhat resistant to anæsthesia. Quick-acting anæsthetics, single or in combination, such as chloralose + urethane, though producing rapid action, are often found to kill the animal during operation, or the period of testing.

results compared well with the results on spinal cats.

Bengal Immunity Research Lab.,
Calcutta,
December 23, 1944.

A. N. BOSE.
J. K. GHOSH.

THREE NEW RECORDS OF NEMATODE WORMS FROM PUNJAB AND THE UNITED PROVINCES

IN the paper are recorded *Schwartziella nodulosa* (Schwartz, 1928) and *Trichostrongylus colubriformis* from buffaloes and *Capillaria bovis* from buffaloes and goats in Punjab and U.P. Specimens were collected from U.P. in February 1944 from buffaloes slaughtered at Bareilly. *Capillaria bovis* was recovered in August 1944 from two goats received from the General Disease Investigation Section of the Imperial Veterinary Research Institute, Izatnagar. Examination of the intestines of buffalo calves in Punjab was undertaken in October 1944 and in Bareilly it was confined to nodules only.

Schwartziella nodulosa

As the parasite is economically important its incidence was investigated and in the table are given the numbers found in the nodules as well as those lying free in the intestinal lumen respectively.

Number of Parasites

(*a*) Embedded in nodules—
31, 5, 11, 88, 44, 35, 19, 31, 10, 25.

(*b*) Free in the lumen—
69, 48, 18, 51, 90, 52, 50, 89, 22, 65.

At Sialkot all the twenty calves ranging in age from one to two years harboured the parasite. A very large number of adult buffaloes examined at Izatnagar were found to be free from worms.

The parasite was originally described by Schwartz (1928) as *Cooperia nodulosa* from a carabao. Le Roux (1936) and Travassos (1937) transferred the species to their newly created genera Schwartziella and Paracooperia respectively. Matoff (1938) records the worm from Bulgarian buffaloes and states that it occurs in the nodules in the cæcum also. The author has examined a large number of nodules from cæcum but has never met the parasite. Instead œsophagostome larvæ have always been found.

Capillaria bovis

The parasites were collected from buffalo calves and goats in small numbers, five being the largest met with in a calf. The parasite has not previously been collected from these animals in this country.

Host—*Capra hircus* and *Bos bubalus*.
Location—Small intestine.
Locality—Izatnagar, U.P.

Trichostrongylus colubriformis

The parasite was twice collected from calves at Izatnagar. It has not been previously recorded from this animal.

Host—*Bos bubalus*.
Location—Small intestine.
Locality—Izatnagar, U.P.

Military Dehydrated Meat Factory,
Agra, M. M. SARWAR.

January 1, 1945.

Le Roux, P. L., *Jl. Helm.*, 1938, **14** (**2**), 113–18. Matoff, K., *Helm. Abstracts*, 1938, **7**, No. 266. Schwartz, B., *Proc. U.S. Nat. Mus.*, 1928 **74**, Art 20. Travassos, L., *Monograph Do Inst. Oswaldo Cruz.*, 1937, **1**, 1–511.

ACETYLCHOLINE TRANSMISSION AT NERVE ENDINGS

DURING experiments on frog stomach in December 1944 and January 1945, it was noticed that muscles from stomachs of certain frogs were absolutely refractory to the action of acetylcholine (1 in 10^8 to 1 in 10^4), even after treatment with eserine (1 in 10^7 to 1 in 10^4), though they responded normally to alternating current, direct current and potassium. As this seemed anomalous, it was decided to investigate the action of acetylcholine on other tissues, such as the heart and rectus abdominis of the same frogs, the stomach muscles of which were refractory to the action of acetylcholine. The following effects were observed:—

1. *A Natural Atropine Effect.*—The stomach was insensitive to acetylcholine (1 in 10^8 to 1 in 10^4), even after treatment with eserine. The heart was also found refractory even after eserinisation. In the former contraction was produced by electric current, and in the latter complete standstill was produced by vagus stimulation. The rectus abdominis was sensitive; so also dog stomach and rabbit gut, thus eliminating any doubt regarding the potency of acetylcholine (B.D.H.) employed.

2. *"Acetylcholine Escape".*—In these hearts acetylcholine may have a temporary mild inhibitory effect; the muscle, however, soon adapts, and normal beats are restored after four to five contractions in the continued presence of acetylcholine. Before return to the normal the beats are ougmented. The recovery is not due to destruction of acetylcholine as shown by the fact, that change of solution has no effect. Further if the muscle has adapted to low concentrations of ethylcholine (1 in 10^7) higher concentrations (1 in 10^6 to 1 in 10^4) are rendered inert. Inhibition is produced if acetylcholine is alternated with Ringer solution. These results are identical with those found in plain muscle (Singh, 1942). After adaptation to acetylcholine, the vagus stimulation still brings the heart to a standstill.

3. *Augmentation of the Beats.*—Far from producing inhibition, the beats were augmented. The heart may become hyperirritable in high concentrations of acetylcholine (1 in 10^5), as shown by numerous extra systoles. There may be even contracture as found in plain muscle.

4. *Effect of Initial Length.*—The inhibitory effect of acetylcholine is augmented by increase in initial length of the heart fibres. Acetylcholine which may produce no effect on the heart may produce inhibition, if the latter is distended by increasing the perfusion pressure. These effects are identical with those found in plain muscle, wherein it was found that with increasing length of fibres, not only contraction but also inhibition was enhanced.

In the above experiments, purely mechanical effects may produce identical results, an increase in perfusion pressure may prevent the heart from contracting, and so simulate inhibition. The effects of acetylcholine, therefore, should be controlled by saline only and by the action of atropine. Moderate distension of the heart thus favours excitation as well as inhibition. This is necessary as otherwise when

the excitability is increased, the heart may not relax properly.

5. Acetylcholine in small concentrations potentiates the response to electric current in frog stomach (Singh, 1939). It is possible that chemical transmission potentiates electrical transmission.

Department of Physiology,
Medical College,
Hyderabad, Sind,
January 19, 1945.
INDERJIT SINGH.
K. B. SEHRA.

Singh, I., *J. Physiol.*, 1939, **96**, **367**; *Ind. Journ. Med. Res.*, 1942, **30**, 629.

A NEW BACTERIAL LEAF-SPOT ON *PIPER BETLE*

A NEW type of bacterial leaf-spot disease was observed on *bangla* variety of pan (*Piper betle*) at Ramtek during December 1943. So far, under field conditions, the disease has not been observed to occur on *kapuri*, *kakher* and *gangari* varieties. The mode of infection and symptoms of this leaf-spot disease are entirely different from those described by Raghunathan (1926, 1928), Park (1934), Nirula (1931) and Asthana and Mahmud (1944). As far as known to the authors this disease has not so far been reported from anywhere else.

The earliest symptom of the disease is the presence of extremely minute pale-yellow spots either on the lower or upper sides of the leaves. Within a couple of days the initial spots turn dark-purple in colour and are slightly raised. There are no corresponding spots or discolouration on the other side of the leaf. Yellow coloured zones with water-soaked areas are not formed round these spots as in the leaf-spot disease described by Raghunathan (1926). The spots may appear inbetween the veins or on or along the veins. In the former cases they are more or less round or roughly angular while in the latter they are irregularly elongated or branched like fern leaves. They vary considerably in size, measuring from 1 mm. to 1 cm. across, and are generally apparent only on one side of the leaves. In cases where rotting has advanced considerably these spots are visible on both the sides. The infected leaves gradually turn yellow and fall off. The disease has not been observed to cause any damage to roots, stems or petioles.

Healthy leaves of *kapuri* and *bangla* varieties were artificially inoculated by pure cultures of the pathogen. Inoculations were either carried out by spraying the leaves with a suspension of the bacterium in sterile distilled water or simply by smearing the leaves with the pure cultures of the organism. Under both the methods positive results were obtained on either of the varieties. *Kapuri* variety proved as susceptible to the disease as *bangla*. Under moist conditions the symptoms of the disease appeared within 12 to 18 hours. Infection appeared with equal readiness on both the sides of the same leaves of all ages. On re-isolation the same pathogen was isolated from all the infected leaves. Inoculations of roots, stems and petioles gave negative results.

Parenchymatous cells are chiefly infected, the pathogen being intra-cellular. In the earlier stages of infection the organism is found only in the epidermal cells but later on it invades spongy and palisade cells. In highly advanced stages of rotting the pathogen is occasionally seen in the phloem and xylem vessels as well, though mostly in the former. The invaded cells slightly enlarge in size, turn dark-lemon and disintegrate. The leaves turn yellow and gradually drop off. Two to three spots are enough to kill a leaf. In some cases the parasite enters the host through the stomata but in others the entry appears to be directly through the epidermal wall. There are no stomata on the upper side of pan leaves of *bangla* and *kapuri* varieties yet the entry of the organism is easily effected by spraying or keeping a small bit of inoculum there. In some cases the organism has been found to enter through the stomata on the underside of the leaves while in others the epidermal cells are clogged but the neighbouring stomata and the cells beneath them are absolutely free of it. All these show that the presence of stomata or wound are not at all essential for the entry of this bacterium into the host cells.

On bouillon-agar plates the organism produces sky-white colonies within 12 to 18 hours which later on turn maize-yellow. The colonies are round, thin and flat, glistening and marked with ridges. In texture they are dry and brittle. The colonies have a distinct central area surrounded by an outer ring and a lobed margin; the lobes occasionally branching out fern-like and appear fan-shaped. On bouillon-agar streak the growth is echinulate in formation but in stab cultures it is filiform.

The pathogens are rod-shaped bacterium, measuring $1\cdot 2 \times 2\cdot 5\,\mu$ and occur in pairs or in chains of 3 to 12 or even more cells at a time. They are fairly motile both in solid and liquid media and in young and old cultures. Twenty-four to 48 hours-old cultures show very brisk motility of the sinuous swimming type, rarely straight and frequently with spells of quick and sudden tumbling on the short axis. At 30° to 38° C., the sporulation, even in young cultures, is in abundance. The spores remained viable even when they were heated to 90° C. for ten minutes.

The characteristics of the pathogen as described above are quite different from those of *Bacterium betle* Reg. (1926, 1928). It is presumed to be a new species and is provisionally named *Bacillus betle*.

Mycology Section,
Agricultural Research Institute,
Nagpur, C.P.,
November 17, 1944.
R. P. ASTHANA.
K. A. MAHMUD.

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CLEISTOGAMY IN SOME OF THE FLOWERS OF *CAJANUS INDICUS* L.

Cleistogamy is a common phenomenon among the different families of angiosperms and is chiefly characterised by autogamous type of pollination and seed production. The development of cleistogamic flowers in an otherwise normally developing chasmogamic form due to certain environmental change caused by drought, excess of moisture, shade, surrounding soil, etc., is separately grouped by Uphof[2] as "ecological cleistogamy". The exact edaphic factor concerned in inducing the production of cleistogamous flowers are in many cases difficult to determine.

In the course of the breeding work in *Cajanus indicus*, many cases of cleistogamic tendency was noticed in the majority of the flowers. The flowers of *Cajanus* are considered to become chasmogamic having insect visitors like *Megachile lanata* and *Apis florea*. Examination of the flower buds at various stages indicated that the pollen grains mature early and anthesis takes place 34 hours before the actual opening of the flower. The stigmatic surface gets profusely dusted with the pollen which begin to germinate and form pollen tubes, thus resulting in autogamy. Mehta and Dave[1] also observed a similar condition in their studies in *Cajanus indicus* and state that anthesis takes place at least 24 hours before the opening of the flowers. They do not attribute any significance to this interesting feature. Pollen grains were found to spontaneously germinate soon after anthesis on any surface of the flower such as petal, filaments, etc.; the stimulus of the stigma was not, therefore, necessary for initial germination, a character reminescent of cleistogamous flowers. This feature is similar to Warming's[3] observation in *Campanula uniflora* from Greenland. In this plant the pollen grains get deposited on the stigmatic surface in the bud condition itself developing pollen tubes and when further pollination is no longer possible the flowers become chasmogamic. In *Cajanus indicus* the author's observations indicate that the percentage of such ecological cleistogamic flowers goes up to 80 per cent. in the months of September to November. The exact edaphic factors responsible for such a feature have not been determined.

Department of Agriculture,
Bangalore, D. M. Gopinath.
January 10, 1945.

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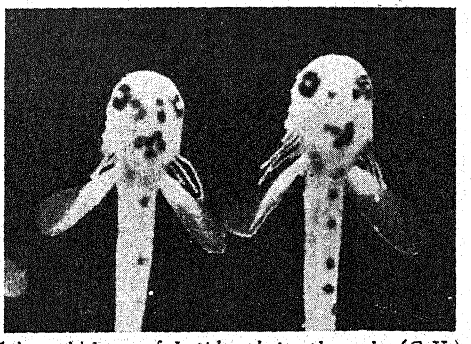
ON THE OCCURRENCE OF 'EXTERNAL' GILLS IN THE LOACH—*LEPIDOCEPHALUS THERMALIS* (C.V.)

True external gills of ectodermal origin occur only in Crossopterygii, Dipnoi and Amphibia. The embryos of elasmobranchs possess long filamentous gill lamellæ projecting out of the gill clefts. Such endodermal gill filaments have been noticed in the larvæ of *Gymnarchus* and *Heterotis by* Budget and *Misgurnus* by Gotte.

The occurrence of 'external' gill filaments in Teleosts is a rare feature. While studying the early development of the loach—*Lepidocephalus thermalis* (C.V.) it was noticed that the larvæ possessed long gill filaments projecting out of the opercular opening. Second day after hatching the larva was observed to develop a filamentous vascular loop projecting out of the opercular opening. The loop gradually elongated in size. About the fifth day four such filaments were noticed on either side. During the third and the fourth weeks the filaments branched considerably. They were kept in constant movement by the opercular flaps. These filaments were gradually absorbed giving place to normal internal gills between the fourth and the fifth weeks. A microscopical examination of the sections of the head of the larva revealed that the 'external' gill filaments are derived from the endoderm covering the branchial bars.



5 days old larva of *Lepidocephalus thermalis* (C.V.) showing 'external' gill filaments

It is well known that both *Misgurnus* and *Lepidocephalus* perform intestinal respiration taking air directly by the mouth and passing it out of the anus and that they are well adapted for living in muddy waters deficient in oxygen. The development of larval 'external' gills in these two loaches is probably intended to provide a greater respiratory surface to surmount the adverse conditions prevailing in such muddy waters.

Fisheries Section,
Department of Agriculture,
Bangalore, B. S. Bhimachar.
February 8, 1945. Augustine David.

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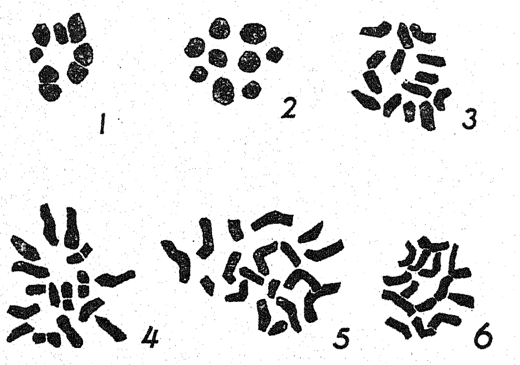
THE CHROMOSOME NUMBERS IN THE FAMILY ANONACEÆ

The family Anonaceæ is one of the little known families in respect of its chromosome numbers. In 1936, Locke[1] noted that the haploid number of chromosomes in *Asimina triloba* was probably nine. One of us (R. D. A.), in 1937,

found[2] that the haploid number of chromosomes in *Anona squamosa* and *A. reticulata* was seven. Kumar and Ranadive[3] (1941) also found the same number in meiosis in these two species, as also in the two other species they investigated, namely, *A. cherimoliana* and *A. muricata*.



Very recently the present authors investigated some more members of this family and found that the haploid number of chromosomes was eight in *Artabotrys odoratissimus* and nine in *Polyalthea longifolia*. A study of the somatic divisions in the root-tips revealed that the diploid number of chromosomes is fourteen in *Anona squamosa* and *A. reticulata*, sixteen in *Artabotrys odoratissimus* and eighteen in *Polyalthea longifolia*. This confirmed the haploid number of chromosomes previously noted by us in these plants.

One of us (R.D.A.) wishes to express his best thanks to Prof. S. V. Shevade, Dr. T. S. Mahabalé and Prof. V. G. Phatak for their keen interest and help in the work.

Gujarat College, Ahmedabad, J. J. ASANA.
Wilson College, Bombay, R. D. ADATIA.
January 20, 1945.

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ON SOMATIC DIVISION, REDUCTION DIVISION, AUXOSPORE-FORMATION AND SEX DIFFERENTIATION IN *NAVICULA HALOPHILA* (GRUNOW) CLEVE

Navicula halophila occurs in good quantity at Madras. The life-history of the Diatom was studied by the author with the help of laboratory cultures. Special attention was devoted to its auxospore-formation and the nuclear details connected with the process.

Somatic division takes place in the usual manner, the chromosomes being arranged in a ring around the spindle at metaphase as is characteristic of Diatoms. The chromosome number appears to be 48-52 (2 n). After cytokinesis, two new valves are secreted by the daughter protoplasts inside the old valves.

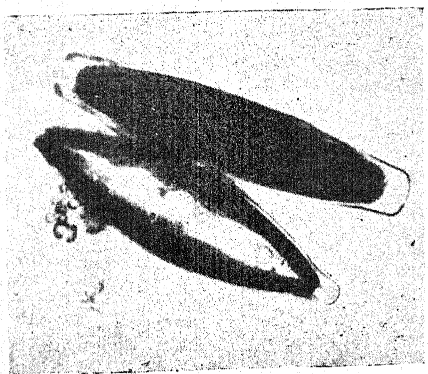
During auxospore-formation two cells come near each other (Fig. 1) and secrete a common mucilaginous envelope. The nucleus of each cell divides meiotically and forms two nuclei. All the stages of the meiotic division were observed. The haploid number of chromosome appears to be 24-26. The contents of each cell then divides into two protoplasts, each protoplast receiving one haploid nucleus. The haploid nucleus in each daughter-protoplast undergoes the second division and forms two nuclei. Of these two nuclei in each daughter-protoplast, one degenerates and the other remains functional, so that ultimately, each daughter-protoplast (gamete) has one single haploid nucleus. Finally two gametes are organised in each of the conjugating cells (Fig. 4).

The two gametes of one of the cells escape out of the valves and fuse with the two gametes of the other cell. The latter gametes remain passive and do not move out of the parent valves. Both the zygotes are formed in the latter cell (Fig. 5).

The zygotes (auxospores) germinate after a few hours of rest and form two new Diatom cells (Fig. 6). The two gametic nuclei inside each auxospore do not fuse for a long time and fuse only after the auxospore has reached its full size.

The nuclear details connected with auxospore-formation among the Pennate Diatoms have been recorded only in a few forms (*Cymbella lanceolata*, Geitler 1927 *a*; *Cocconeis placentula*, Geitler 1927*b*; *Nitzschia subtilis*, Geitler 1928; *Synedra ulna*, Geitler 1939; *Rhoicosphenia curvata*, Cholnoky 1927; *Anomœoneis sculpta*, Cholnoky 1928; *Cymbella cistula*, Cholnoky 1933; and *Gomphonema geminatum*, Meyer 1929). But nothing is known regarding the nuclear details connected with auxospore-formation in the very common genus, *Navicula*, though auxospore-formation has been previously recorded in the genus [*Navicula Grevillei* (Smith 1856); *N. serians* and *N. rhomboides* (Carter 1865); *N. cuspidata* var. *ambigua* and *N. elliptica* (Pfitzer 1871); *N. viridula* and *N. scopulorum*, (Karsten 1896); *N. crucigera* (Karsten 1897); *N. didyma*, *N. ramosissima*, *N. directa*, *N. subtilis* and *N. pygmœa* (Karsten 1899); and *N. seminulum* (Geitler 1932)]. In the present form the author was able to follow all the details of the nuclear changes connected with the auxospore-formation. This appears to be the first complete account of the nuclear changes connected with auxospore-formation in this genus.

Again, in the Pennate Diatoms, previously, both isogamous conjugation [*e.g.*, *Rhopalodia gibba* (Klebahn 1896); *Epithemia zebra* var. *saxonica* and *Denticula Vanheurckii* (Geitler 1932)] and anisogamous conjugation [*e.g.*, *Cymbella lanceolata* (Geitler 1927 a); *Nitzschia subtilis* (Geitler 1928); *Gomphonema parvulum* var. *micropus* (Geitler 1932)] have been recorded. In the former the gametes of both the cells are equally active and as a result, the two zygotes are formed between the two pairing cells. In the latter type of conjugation, of the two gametes that are formed in each pairing cell, one is active and motile,



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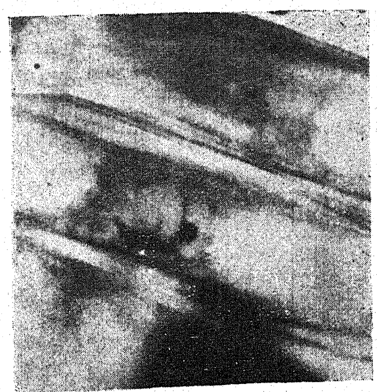

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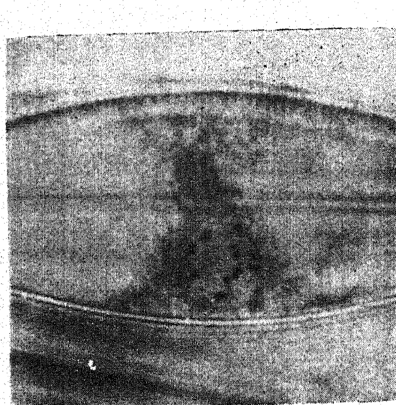

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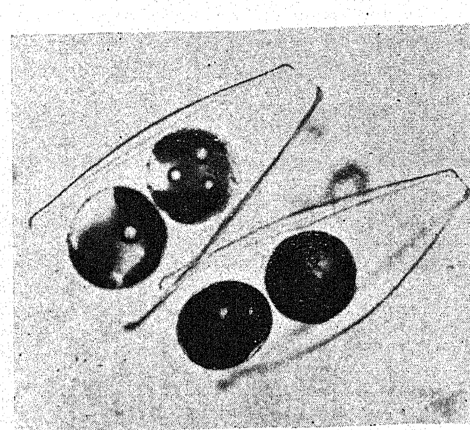

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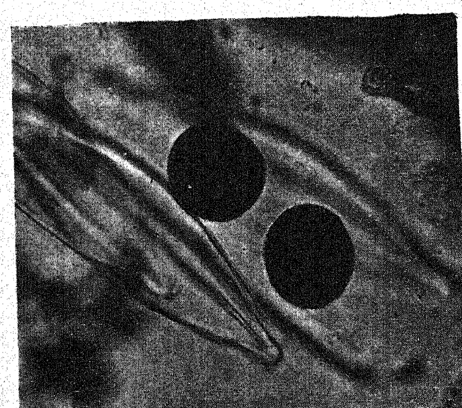

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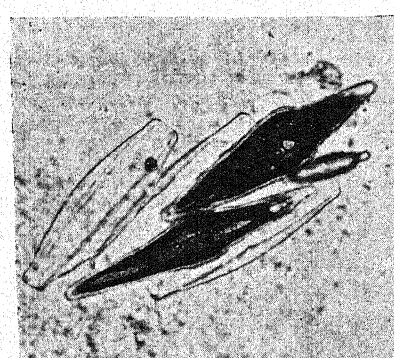

6

Navicula halophila (Grunow) Cleve

FIG. 1. Two cells just come near each other (living material) × **650**.

FIG. 2. Synizesis × 1500.

FIG. 3. Diakinesis. × 1500.

FIG. 4. Two gametes in each one of the pairing cells ready for conjugation (living material) × **500**.

FIG. 5. Two zygotes (auxospores) inside the valves of one of the conjugating cells (female) (living material). × 500.

FIG. 6. Two zygotes (auxospores) germinating. Note the two auxospores are seen inside the valves of one of the conjugating cells (female). × 350.

while the other is passive. During conjugation, the active gamete of one cell passes over to the opposite cell and fuses with its passive gamete and the active gamete of the latter cell behaves in a like manner and fuses with the passive gamete of the former cell. As a result of this a zygote is formed in each of the two conjugating cells. Geitler (1935, page 154) with reference to this phenomenon states that "the physiologically anisogamous behaviour involved in the formation of two gametes permits the interpretation that each mother-cell forms two gametes of opposite sex, a male motile gamete and a female non-motile gamete. The mother-cells themselves may, accordingly, be regarded as hermaphroditic and the entire behaviour would, from this view-point, correspond to that involved in the conjugation of the Ciliates. So far as we know, sex determination occurs phenotypically in all cases hitherto investigated. A sex chromosome mechanism has not been observed nor can it be expected."

In the case of the present Diatom, the conjugation is anisogamous, but, the anisogamy observed here is quite different from those recorded previously among the Pennales. Here, of the two gametes that are formed in each cell, instead of one of them being active and the other passive, *both* the gametes of one cell are active (*i.e.*, physiologically male), while *both* the gametes of the other cell are passive (*i.e.*, physiologically female), with the result that both the zygotes are formed in the latter cell, unlike in the previously recorded cases, where a zygote is formed in each of the two cells. The mother-cells in the form under investigation (*Navicula halophila*), therefore, should be regarded as diœcious, *i.e.*, as either male or female and not as monoecicus (hermaphroditic) as in the previously recorded cases.

The author wishes to express his indebtedness to Prof. M. O. P. Iyengar, M.A., Ph.D. (Lond.), F.L.S., for his guidance and help throughout the course of this work. His sincere thanks are also due to the authorities of the University of Madras for the award of a research studentship during the tenure of which this investigation was carried out.

University Botany Laboratory,
Madras, R. SUBRAHMANYAN.
December 11, 1944.

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HISTIDINE AND TYROSINE IN HÆMOGLOBIN FORMATION

OF the essential amino-acids present in the protein part of hæmoglobin, histidine is quantitatively one of the most important. It was shown to have a hæmatogenic action by Fontes and Thiovolle (1930)[1] in experiments on normal dogs and rabbits. Barrie (1937)[2] found that guineapigs gave a reticulocyte response to histidine hydrochloride and attributed this effect to the stimulating action of histidine hydrochloride on gastric secretion and the consequent increase in the production of the hæmopoietic factor effective in pernicious anæmia. Cuthbertson *et al.* (1931)[3] also consider this amino-acid to have a stimulating action on hæmopoietic tissue. The results of administration of histidine in human anæmias have, however, been generally negative (*cf.* Cuthbertson, *loc. cit.*, Dominici and Pentai, 1931[4] and Tochowiez, 1936[5]).

In our experiments the object of which was to ascertain if this amino-acid provides structural material for the formation of hæmoglobin, the effect of dietary histidine was studied on animals suffering from experimental anæmia.

The experimental procedure was exactly the same as that used with tryptophane (Yeshoda, 1943).[6] Rats, made anæmic by injection of phenylhydrazine, were used. Histidine was removed from hydrolysed casein by silver precipitation (Vickery and Leavenworth, 1928).[7] All animals experimental as well as controls, received 20 mg. of tryptophane to make up for the destruction of tryptophane during acid hydrolysis. The animals in the control group received no histidine, while those in the experimental group were given 50 mg. of histidine hydrochloride daily from the onset of acute anæmia. The results tabulated below show that histidine significantly accelerates the formation of erythrocytes and hæmoglobin. Animals receiving histidine had their cell count and hæmoglobin restored to normal in twelve days on the average, while on a histidine-deficient diet the time of recovery was usually a month.

The effect of histidine differed from that of tryptophane in connection with their mode of action; while with tryptophane the hæmoglobin formation lagged behind the increase in R.B.C. with histidine both cell count and hæmoglobin content were simultaneously normalized.

TABLE I
Histidine—Average values for R.B.C. and hæmoglobin

	Histidine group			Histidine deficient group		
	Days		In-*rease	Days		In-crease
	0	12	%	0	12	%
R.B.C.	2·99	6·62	121·4	2·99	4·89	63·4
Hæmoglobin	7·24	13·89	91·8	7·13	10·30	44·4

TABLE II
Statistical analysis

No. of animals	Histidine group		Histidine deficient group		$\frac{X_1 - X_2}{\sqrt{\epsilon_1^2 + \epsilon_2^2}}$
	6		6		
	Mean increase X_1	Standard error of mean ϵ_1	Mean increase X_2	Standard error of mean ϵ_2	
R.B.C.	3·63	·1219	1·92	·1581	7·76
Hæmoglobin	6·65	·2247	3·13	·3818	7·95

Similar experiments carried out with tyrosine, the results of which are tabulated below, show that this amino-acid plays no essential role in hæmopoiesis.

TABLE III
Tyrosine—Average values for R.B.C. and hæmoglobin

	Tyrosine Group			Tyrosine deficient group		
	Days		In-crease	Days		In-crease
	0	12	%	0	12	%
R.B.C.	3·35	6·18	86·1	3·31	6·24	88·5
Hæmoglobin	8·06	13·18	63·5	8·14	13·07	60·5

Acknowledgement is made to Prof. M. Damodaran for his interest in the work.

University Biochemical Lab.,
Madras,
January 29, 1945.
K. M. YESHODA.

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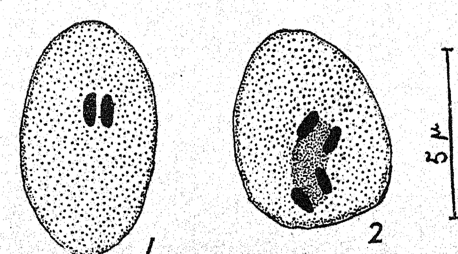
MITOSIS DURING BUDDING IN *SACCHAROMYCES CEREVISIAE*

THERE is little agreement as to whether during budding the nucleus of *S. cerevisiæ* divides by mitosis (Kater,[1] Beams *et al.*,[2] Richards,[3] Henrici[4]). Guilliermond[5] classifies yeasts as haplo- and diplobiontic depending on whether meiosis takes place after or before zygote formation. This is based solely on the assumption that since nuclear reduction occurs in higher Ascomycetes, in yeasts also "meiosis must occur within the ascus". Any advance in our knowledge of the cytogenetics of the yeasts depends on a demonstration first of mitotic division during budding. Badian[6] observed during budding two chromosomes which split longitudinally to give rise to two daughter-nuclei but Guilliermond is disinclined to accept his conclusions. Darlington[7] states that "the effective test of a nucleus is not so much in its chemical and physical properties, but in its behaviour: *a nucleus is a cell-body which arises or reproduces by mitosis*". Strict application of the above test to yeasts renders doubtful even the identification of a particular structure in the yeast-cell as the nucleus.

Every text-book on Cytology warns the reader of the caution to be exercised in interpreting certain appearances as amitosis. Re-investigations in many cases with improved technique have resulted in demonstration of mitosis in cells which have previously been thought to divide by amitosis and Darlington mentions "that the apparent contradiction to genetic principles in the occurrence of amitosis need no longer be taken seriously."

It was thought therefore, that a careful investigation of the behaviour of the nucleus during budding was an essential introduction to a study of the cytogenesis of the yeasts.

The strain of *S. cerevisiæ* (*N.C.T.C.* 3007) employed by us was SC 9 in the National Collection of Type Cultures, India. Wort cultures were made from wort-agar slants and conditions were standardized so that in a smear



almost all cells wore practically at the same stage of development. Systematic examination demonstrated that vital changes take place in the nucleus at definite intervals and that the whole process of division of the nucleus takes only about 20 minutes. Indeed, the anaphase stage is passed through so quickly that unless one is very careful it may be missed completely.

Among the various fixatives and stains tried, smears fixed in Carnoy and stained with

Heidenhain's hæmatoxylin were found to give excellent pictures. No particular treatment was found necessary to remove the metachromatic granules from the cells. In smears fixed for 60 minutes in Carnoy's fluid, mordanted overnight in iron-alum and kept in hæmatoxylin for 24 to 36 hours, careful differentiation gives only pictures of the chromosome stages. We have smears where large number of cells are at particular phases of the mitotic cycle.

There are only two chromosomes, both identical in appearance (Fig. 1). The measurements of the two chromosomes in four cells at the same stage of the cycle are as follows:— (1) $1 \cdot 33\ \mu/0 \cdot 33\ \mu$, $1 \cdot 33\ \mu/0 \cdot 4\ \mu$; (2) $1 \cdot 33\ \mu/0 \cdot 4\ \mu$, $1 \cdot 33\ \mu/0 \cdot 27\ \mu$; (3) $1 \cdot 33\ \mu/0 \cdot 33\ \mu$, $1 \cdot 00\ \mu/0 \cdot 33\ \mu$; (4) $1 \cdot 00\ \mu/0 \cdot 33\ \mu$, $1 \cdot 00\ \mu/0 \cdot 33\ \mu$. At anaphase shown in Fig. 2 they measure $1 \cdot 00\ \mu/0 \cdot 33\ \mu$.

Badian's paper has evoked contradictory opinions. While Gulliermond rejects Badian's interpretations, Henrici considers that "the two chromosomes described by him are more definite than the vague accumulations of minute chromatin granules described by Guillermond". It appears as if Badian saw structures missed by the other workers. *S. cerevisiæ* does not form an exception to the general rule, for, nuclear division during budding is by mitosis.

Our thanks to Mr. M. Sreenivasaya for his active interest and encouragement. One of us (M.K.S.) wishes to thank Messrs. The K.C.P., Ltd., Uyyuru, for the generous grant of a studentship.

Fermentation Technology Section,
Indian Institute of Science,
Bangalore, M. K. SUBRAMANIAM.
February 1, 1945. B. RANGANATHAN.

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ON THE FOOD OF MULLETS*

MULLETS are a group of food-fishes found in seas, backwaters and estuaries of our country.

The food of twelve species of Mullets is described by examining their stomach-contents. (1) *Mugil klunzingeri* Day. (30 specimens, 8-13 cms.): *Amphora, Cymbella, Pleurosigma, Eremosphæra, Copepods* and sand grains. (2) *Mugil jerdoni* Day. (15 specimens, 8-10 cms.): *Biddulphia, Coscinodiscus, Cymbella, Fragillaria, Pleurosigma, Rhizosolenia, Eremosphæra, Peridinians,* larval bivalves, larval gastropods, fish-eggs, fish scales and sand grains. (3) *Mugil dussumieri* Cuv. & Val. (25 specimens, 8-10 cms.): *Coscinodiscus, Cymbella, Fragillaria, Gomphonema, Navicula, Nitzschia, Pinnularia, Pleurosigma* and sand grains. (4) *Mugil œur* Forskal (12 specimens, 9-10 cms.): *Biddulphia, Coscinodiscus, Navicula, Nitzschia* and sand grains. (5) *Mugil sehali* Forskal. (61 specimens, 9-21 cms.): Algal filaments, *Bacteriastrum, Biddulphia, Coscinodiscus, Fragillaria, Nitzschia, Pleurosigma, Rhizosolenia, Thalassiothrix, Trichodesmium,* larval polychætes and sand grains. (6) *Mugil crenilabris* Forskal. (20 specimens, 10-15 cms.): *Coscinodiscus, Navicula, Pinnularia, Pleurosigma, Tabellaria,* larval polychætes and sand grains. (7) *Mugil cœruleo-maculatus* Lacep. (30 specimens, 9-12 cms.): *Biddulphia, Chætoceras, Coscinodiscus, Navicula, Pinnularia, Pleurosigma, larval* polychætes, *Tabellaria* and sand grains. (8) *Mugil amarulus* Cuv. & Val. (5 specimens, 5-8 cms.): *Coscinodiscus, Eremosphœra* and sand grains. (9) *Mugil labiosus* Cuv. & Val. (5 specimens, 5-8 cms.): Algal filaments, *Coscinodiscus* and sand grains. (10) *Mugil olivaceus* Day. (20 specimens, 7-9 cms.): *Bacillaria, Coscinodiscus, Fragillaria, Navicula, Pleurosigma* and sand grains. (11) *Mugil troschelii* Bleeker (123 specimens, 10-35 cms.): Algal filaments, sea-weed (*Caulerpa* sp.), *Chætoceras, Chroococcus, Cœlosphœrium, Coscinodiscus, Eremosphœra, Glœocapsa, Hemidiscus, Navicula, Nitzschia, Pleurosigma, Rhizosolenia, Tabellaria, Thalassiothrix,* Foraminifers. *Tintinnus,* larval polychætes, Nauplius larvæ, Ostracods and sand grains. (12) *Mugil waigiensis* Quoy. and Gaim. (126 specimens, 10-45 cms.): Algal filaments, *Bacteriastrum, Biddulphia, Coscinodiscus, Detonula, Eremosphœra, Fragillaria, Gœlenkinia, Hemidiscus, Navicula, Nitzschia, Pleurosigma, Rhizosolenia, Tabellaria, Thalassiothrix, Trichodesmium, Dinophysis,* Foraminifers, *Tintinus,* larval polychætes, Copepods, Amphipods, Ostracods, larval gastropods and sand grains.

Discussion.—Mullets are chiefly plankton-feeders, diatoms and larval bristle-worms forming the major portion of their food. They, however, supplement their diet by browsing at the water margin on vegetable matter, and this accounts for the presence of sand grains in their stomachs. The presence of fish-eggs in a few specimens of *Mugil jerdoni* Day. is considered accidental.

Laboratory of the Asst. Director
of Fisheries, Inland Development,
Chepauk, Madras, P. I. CHACKO.
September 1944. R. S. VENKATRAMAN.

* Published with the permission of the Director of Industries and Commerce, Madras.

REVIEWS

Climate and Labour. By W. Burridge. (Kitabistan, Allahabad), 1944. Pp. 167. Rs. 5-4-0.

Men are often irrational and the student of Science is no exception. The scientist who is meticulous in his investigations may stubbornly uphold views which would not stand the test of rational analysis. We have a sample of the above in the volume with the pretentious title under review.

The reader's interest is piqued by the claim in the inside cover page that the work deals with "the physical build of the body and the dietetic conditions which render men so comfortable on a hot day that they fall asleep on a hot verandah while pulling a punkah rope. The author notes that the vast majority of the population of India must be capable of such work and sleeping, and that the capacity to do it fits a man to follow rather than to lead. The social system of Hinduism is adapted to such conditions rather than Western Democracy." It is reasonable, therefore, to enquire the basis on which such astounding conclusions are based. The reader is earnestly enjoined to appreciate that the author arrived at the conclusions not "as a result of questioning a dozen or so dyspeptics, but after assessing the replies of many hundreds, even thousands, of healthy young Indian male and female medical students to questions concerning their own hot-weather experiences". Since these replies were elicited at many written and oral examinations one begins to wonder how far testimony given under such conditions is valid and whether the students were really healthy? The picture of the Indian student is not very complimentary for, the author states: "It is further my experience that Indian students, especially the ladies, who read from morn to eve and long into the night for examination purposes do become anæmic. Indeed, more students appear to me to do badly through lack of sleep and overwork than from non-prosecution of studies" (p. 129).

The questions also appear to have been put in forms not conducive to elicit accurate replies, for, it is mentioned (p. 15): "Unfortunately, a limited number of the ladies appeared to imagine that this was an unjustified enquiry into the secrets of their bed chambers, and, therefore, I thought it better to put the question into a different form by going to the dogs instead. But, while the problem in its first form (how he or she lay in bed in the cold and hot weather respectively) could be answered by anybody who applied his book-learning to facts within his own personal experience, the second form required that the student should also be an ordinary observer of the world around him; yet many more students failed in the observation test than were young ladies shocked at imagined enquiries into bed-chamber secrets."

It is on this unscientific foundation that the author bases his conclusion that "Nietsche's doctrine of a herrenvolk and a heerden volk is a germanised version of what has been practised for centuries in India as caste" and that "the climatic conditions of India unfit it for democracy".

The book is interesting to read and is recommended to interested readers as an example of how so-called scientific facts could be made to fit in with one's preconceived notions.

M. K. SUBRAMANIAM.

Sex Education. By Cyril Bibby, M.A., M.SC., F.L.S. (Macmillan & Co., London), 1944. Pp. 290. Price 7 *sh.* 6 *d.*

It has been a moot point whether some amount of sex education should be imparted to boys and girls of school-going age. Orthodox public opinion was against such a procedure, but it has been changing during the past few years. The majority of teachers and youth leaders, especially in advanced countries like England and America are in favour of sex education. It is now considered advantageous to impart sex education to youths from a biological point of view rather than allow them to discover things for themselves at an age when emotions begin to assert themselves. Children are curious to know about how babies are made, and about the differences between boys and girls; and young questioners on these points should be gladly and honestly answered. The author insists on the necessity for all teachers to take a course in human and social biology. "If we draw up careful schemes of instruction about how to calculate the time it will take for an express train to get from London to Glasgow or a camel from Cairo to Timbuctoo, is it not rather astonishing that instruction about how life is passed on, and about the relations between man and woman and parent and child, should be left for any chance lesson at the street-corner or in the gutter?"

He is of the opinion that sex education should be a continuous process from the cradle to the grave. The parent, the teacher, and the youth leader ought to know what aspects of sex education are particularly appropriate to different ages. The facts of reproduction in plants and animals should find a place in the biology lessons, which should be made compulsory in all schools.

The four model lectures at the end are masterpieces of how this delicate subject may be handled without being either indecorous or offensive. An excellently classified bibliography on the subject is given at the end of the book for guidance to further reading. The book is well worth a careful study by all parents and teachers.

S. SUBBA RAO.

Flowers in Britain. By L. J. F. Brimble. (Macmillan & Co., Ltd., London), 1944. Pp. x + 393. Price 12 *sh.* 6 *d.*

This attractively produced popular book on flora of Britain would be welcomed by plant lovers in many countries. The title *Flowers in Britain* may suggest to some that the usefulness of the book to those outside Britain would be limited. This is far from the fact. Many of the families of the flowering plants and several of the species described occur in India. The ornamental plants described and so well illustrated are not unfamiliar to plant lovers and amateur gardeners in this country. Apart from this the value of the book lies in the fact that to those really interested in flowers a popular book of this kind would help in visualising the richness and beauty of the flora of another country than one's own.

The author's treatment of the subject is such as to appeal most to laymen not much conversant with botany, yet, the book would be found very useful to students of botany in High Schools and those of the Intermediate standard in Colleges. In the introductory part of the book the author has explained in simple terms some of the elements of botany an acquaintance with which would help the laymen in an intelligent understanding of the principles of plant classification and the necessity for plant systematics. A welcome feature of the book is the division of each family into three groups, namely, wild, ornamental and economic plants. The reason for this as explained by the author is to draw the attention of the laymen and others interested in plant-lore to the fact that economic and ornamental plants have in the wild types their near or distant relatives to whom their descent could be traced. The division of each family into these three groups shows further their inter-relationships.

The entire text is enlivened by the addition of appropriate verses from ancient and modern poets, by giving references to the occurrence in historical times of plants now growing and by mentioning the use made of plants by personages renowned in history. Wherever possible the author has indicated the possible origin of plants and the probable dates of their introduction. Such a treatment as the foregoing makes the reading of this book pleasant and interesting instead of its being one more book of mere mechanical description of plants in dry technical terms. The book is not intended as a standard work of reference but as a guide or companion to amateur gardeners, to ramblers through countryside and to those who hobby in plant collection. To such of these, of whom there would be many in every country, this book is specially intended.

The author has to his credit other books in botany, both technical and popular. Those familiar with his book *Everyday Botany*, will be pleased with this new addition. Considering the time at which the book has appeared, its neat and attractive get-up is to be praised. To suggest that use of superior paper would have enhanced the value of such a well-illustrated book would in these days of paper restrictions sound supercilious. Even otherwise, the excellence of the publication is to be highly commended. It should be said in praise of the author, printer and publisher that it is indeed creditable that in spite of the stress and strain of war to which Britain has been subjected they should have found the time and energy to bring out a book which can divert the minds of men from the horrors and devastations of war to the haven of peace and beauty of nature.

L. S. S. Kumar.

A Text-Book of Plant Physiology. By Shri Ranjan. (Indian Press, Ltd., Allahabad), 1945. Pp. 228. Figs. 81. Price Rs. 6.

The author should be congratulated for bringing out the first text-book of Plant Physiology in India. The lack of an elementary text-book suitable to Indian University curricula was being keenly felt and this book very much satisfies the needs of the B.Sc. students of botany in our country.

The book is well planned and one chapter follows another in logical sequence. The various aspects of Plant Physiology are well treated and the student gets a good elementary idea of the subject. Chapter III—The metabolic biography of a pea—seems to be unnecessary. The practical experiments at the end of each chapter will be found useful by both students and teachers. This would have been better appreciated if the experiments had been described at some length. In many places the value of the book would have been very much enhanced if the author had gone into greater detail. In trying to be brief, the statement is made on page 70—"From the condensation of glycine higher proteins are formed"—this is rather misleading. In the chapter on growth, the latest developments in the field of harmones in plants should have been included. Treatment of photo-periodism in plants should not have been omitted in a text-book of this kind. In mentioning the names of several plant physiologists the author has given dates but has not included a bibliography. At least a list of books for supplementary reading would have been very useful. The appendix on logarithms finds no place in this book. The book is well printed in bold type with numerous illustrations and can be recommended to students. N. N. N.

The Plant Scientist in the World's Turmoils. Contribution to the symposium "Biologists and Rehabilitation", delivered by Dr. Frans Verdoorn of "Chronica Botanica", Waltham, Massachusetts, at Cleveland, Ohio, September 13, 1944.

It looks as though it needs a war to bring any scientific recluse out into the sphere of free thinking in terms of National and International building up of newer methods of research and collaboration—hitherto a little known domain. Dr. Verdoorn's remarkable little six-page document is thought-provoking and contains a clarion call to Biologists all over the world to unite and plan out a constructive future in a world of peace. The author in his own forceful and inimitable style presents a

very strong case for a truly international scientific organization which will not exclude Germany and German split States in order "that the German Scientist, still always one of the world's foremost, will not go 'underground'." Still in the same breath the author says, "the resources of the Allies are bringing this war to an end, an end which will place the scientist once again in a very favourable position, as he will remain free in the post-war world, *not in all but in much more than half of the Allied Territory*". To biologists and scientists in general in Allied Territory this statement is disconcerting. Let us not, at any rate, presume that Dr. Verdoorn presupposes that freedom to the scientist is interrelated with freedom in politics! In the matter of International biological collaboration, extending his own argument further, the author quotes from the United Nations Conference on Food and Agriculture that "the natural sciences are a particularly fruitful field for international co-operation because they are themselves international; basic, physic and biological laws are the same anywhere and universally accepted"; but he says, "co-operation demands an attitude which is not typical of the average biologist". There is great deal of truth in this statement as biological research so far has remained very individual. Nevertheless, the cry for team-work in biological sciences has never been greater than to-day when many biological problems need Applied than Fundamental research. This fact has been very usefully brought out by Dr. Verdoorn. To the thinking biologist the author has given large number of suggestions as to what great quantities of untapped knowledge lay undiscovered and which could be unearthed by improving scientific publications, by instituting abstracting journals, international as well as regional, by truly international societies and commissions for co-operative research and in a host of other ways. The answer to this intriguing question of whether a world federation of biologists will work or not is found in the author's statement, "among biologists all over the world there is a feeling that relations with government (I do not mean any specific political group) should be avoided whenever possible. This may be a sound attitude from the point of view of pure research; from all other points of view it is a mistake. It reveals poor ability to read the signs of the times. Who should know better than the biologist that with the development of organisms their ecology becomes more and more intricate?"

This contribution by Dr. Verdoorn is scintillating reading and is a blunt message not only to the biologist but to the International Scientist. In his own words, "the politician, let us never forget, has to emphasize what divides; the scientist may well emphasize what unifies".

T. S. SADASIVAN.

THE PLACE OF ANGIOSPERM EMBRYOLOGY IN RESEARCH AND TEACHING*

LITTLE that is fundamentally new has been discovered in recent years in the field of descriptive embryology, although many errors and misinterpretations made by previous workers have been corrected and a mass of information added concerning the male gametes, development of embryo-sac, fertilization, endosperm and embryo. In recent years considerable progress has been made chiefly in Europe and America in the field of phylogenetic embryology. The data sifted out from microscopic observations have been made use of in determining the apt positions of certain groups, tribes or families in a natural system of classification. Thus, Empetraceæ has come to be placed with the Bicornes, Lennoaceæ under Tubiflorales as a separate sub-order, Cactaceæ under Centrospermales and Moringaceæ (with Capparidaceæ) under Rhœdales; the genus *Trapa* which has long been placed under Onagraceæ, becomes removed from that family on embryological grounds. Further, some of the embryological characters have been employed to understand the classification within a family as in the case of Liliaceæ and Amaryllidaceæ. When an exhaustive study of all aspects of embryology of a group or family is made, it would be worth developing an 'embryological formula' for each group or family.

From the last two decades a new offshoot, the applied and experimental embryology has emerged out. A thorough knowledge of the sequence of events in the flower is an absolute requisite for success in breeding programmes and in the improvement of crop plants. Though this aspect is still in its infancy, the results obtained till now show a very promising future. It would be very profitable to study in detail the optimum conditions for pollination and fertilization and the effect of X-rays and colchicine on the life-history, the results of which will be highly useful in plant betterment.

In addition to the commonly employed method of serial sectioning in the study of embryology, 'whole-mount' stained preparations which are rendered transparent are of great aid for correct interpretation. Such methods would also facilitate observations of living material under the microscope. A deep, thorough and critical observation alone is capable of bringing out a work of considerable importance; and in teaching, even if the laboratory work makes greater demands upon the energy and resourcefulness of the teacher, this should not be grudged, as through this the young pupil gets such a stimulus for his mental development as is sure to be of use to him ever afterwards in his future career.

In India, with its wealth of Tropical Flora, there is much scope for phylogenetic embryology. There are still several families whose embryological characters are not known or

* Abstract of Presidential Address by Dr. P. Maheshwari of the Dacca University, delivered before the Annual Meeting of the Indian Botanical Society held at Nagpur on 3rd January 1945.

need amplification. A thorough study of these would make it possible for us to bring out a most exhaustive and up-to-date treatise on embryology, in which each worker will write about his own specialised aspect or group, as literature on the subject is now too vast to be surveyed in a satisfactory manner by any one person. Again, a thorough knowledge of the ontogeny of the components of the flower from the time of its inception up to the time of dispersal, alone would aid us to eliminate most of the obstacles in plant improvement and it would no longer remain for the breeder to put pollen on the stigma and 'pray' for results in the ovary!

B. G. L. S.

ST. JOSEPH'S COLLEGE, TRICHINOPOLY, CENTENARY CELEBRATIONS

STARTING from humble origins at Negapatam in the 1844, St. Joseph's of Trinchinopoly had grown into a mighty Centenarian by 1944 and this happy event was celebrated in February 1945. Even before the Centenary Week was at hand its jubilant prospects were obvious to all, thanks to the Inter-Collegiate sports and tournaments which attracted immense crowds to the Mahé Grounds. The week following 8th February 1945 witnessed the College and the Hostels attached to it teeming with guests, resident and otherwise. The occasion was also marked by the jubilation of the College Day Celebrations and the revitalisation of the Old Boys' Association.

An Exhibition consisting of the Departments of Mathematics, Physics, Chemistry, Botany and History was organised in connection with the Celebrations. Sir V. T. Krishnamachariar, K.C.I.E., delivering open the Exhibition, referred to his connection with the College and expressed his admiration for the enormous strides advanced by the institution these years. He stressed the importance of Universities in training the future leaders of the country and the necessity "to rethink and replan the system more intimately to the natural balance of human life and human prosperity". With visitors drawn from the public and the student world the Exhibition was open for three days and it was a success both from the academic and from the popular points of view.

The Centenary Meeting, held on 9th February, was presided over by His Excellency the Hon'ble Sir Arthur Hope, G.C.I.E., M.C., Governor of Madras. His Excellency paid a glowing tribute to the services rendered by the College during the past hundred years in the cause of education, irrespective of caste or creed. Rev. Fr. Rector, in his report, briefly traced the growth of the College since its inception, enumerating the hardships it had to go through at the hands of man and God. He also read messages from Sir S. Radhakrishnan, Sir C. V. Raman, Sir C. R. Reddy, Sir Mohammad Usman, the Archbishop of Bombay and the Apostolic Delegate of the East Indies. Khan Bahadur P. Khalifulla Sahib, First Member, State Council, Pudukottah, extended the greetings on behalf of the Centenary Central Organising Committee. Dewan Bahadur T. M. Narayanaswami Pillai, Member, Public Services Commission, Madras, recalled his association with the College and wished it crowning success in the future. After a vote of thanks from the Very Rev. Fr. A. Bonhoure, S.J., Vice-Provincial of Madura, the meeting came to a close.

The distribution of Prizes for the Centenary Inter-Collegiate Sports was held under the presidency of His Highness Sri Brihadambadasa Raja Rajagopala Tondaiman, Bahadur, Maharaja of Pudukottah. His Highness spoke of the high place that St. Joseph's held in the academic as well as in the athletic fields among the pioneer colleges of S. India.

Realising the dire necessity of a spacious and well-furnished library and a comfortable reading room, the management proposed to institute a Centenary Memorial Library, the Foundation-Stone of which was laid by Mr. D. D. Antony Isar, M.B.E., B.A., LL.B., Administrator, Baghelkhand States Group, Central India.

A social gathering of the Old Boys of St. Joseph's was assembled in the New Hostel Quadrangle under the distinguished presidentship of Mr. Antony Isar. Prof. P. E. Subramania Iyer, Retired Head of the Department of Physics and ex-Secretary of the Old Boys' Association, was also present. Speeches were made by His Lordship the Rt. Rev. P. Thomas, D.D., Bishop of Bangalore, Dr. T. S. S. Rajan, L.R.C.P., M.R.C.S., ex-Minister of Madras, Sri. C. V. Narasimhan, M.A., I.C.S., and Sri. Papali, M.A., Ph.D., of H. H. the Maharaja's College, Ernakulam. Rev. Fr. J. D'Souza, S.J., Principal, Loyola College, Madras, proposed a vote of thanks.

The College Day was celebrated with Lt.-Col. Sir A. L. Mudaliar, Vice-Chancellor, University of Madras, in the chair. Dr. Mudaliar referred to the inestimable services rendered by the College in the cause of higher education and remarked that missionary activities are sure to occupy a sound and proper place in the social and educational setting of the India of tomorrow.

On the 11th February a meeting of the Catholic Former Pupils was held in the Lawdley Hall, presided over by His Excellency The Delegate Apostolic of the East Indies. Rev. Fr. Jerome D'Souza, S.J., Rector and Principal, Loyola College, Madras, welcomed the gathering. A congratulatory address was delivered by Rao Bahadur J. C. Ryan, M.A., Joint Registrar of Co-operative Societies, Madras. Mr. Joseph Thalith, M.A., Bar-at-Law, Retired Chief Justice of Travancore, also addressed the gathering.

A civic reception was accorded to Rev. Fr. Rector in the Municipal Public Hall.

With the Car Procession and a grand Pyrotechnic Display, the Celebrations came to a happy close.

SCIENCE NOTES AND NEWS

The Watumal Foundation of Honolulu and Los Angeles has announced the award of thirteen scholarships and one travelling fellowship to candidates from India chosen from among 1,200 applicants.

The travelling fellowship has been awarded to Dr. J. Makhijani, of Hissar, in the Punjab, Animal Geneticist, to study dairy industry and genetics. The thirteen recipients of the scholarships include Mr. A. N. Bindal, Research Assistant, Indian Institute of Science, Bangalore, to study fermentation and biochemistry; Mr. H. D. R. Ayyangar, of Bangalore, for research in fishery; Sirdar Gurbaxani, Research worker in the Department of Biochemistry, Indian Institute of Science, Bangalore, to study sanitation. Two women, Dr. (Miss) Zubaida Nasir Uddin, formerly of the Punjab University, and Miss Tara Deodhar of Bombay, have also received scholarships.

To ensure an adequate supply of technical personnel to meet the demands of the administrative services and industrial development in the country in the post-war period, the Government of India have appointed a Committee, with Mr. N. R. Sirker as its Chairman, to consider the establishment of a high-grade Technological Institute in India, to provide advanced instruction and training in Technology. The following have been invited to serve on the Committee: Mr. N. R. Sirker (*Chairman*), Mr. A. D. Shroff, Mr. W. W. Wood, Dr. Sir J. C. Ghosh, Dr. Nazir Ahmad, Mr. C. E. Preston, Mr. W. W. Ladden, Mr. M. D. Parekh, Dr. Sir S. S. Bhatnagar, Mr. J. K. Srivastava, Mr. G. I. Mehta, Sir Sobha Singh, Major-General D. R. Duguid, Brig. R. D. T. Woolfe, Mr. W. G. Reid, Sir Frederick Tymms, Mr. P. J. Edmonds, Mr. H. V. R. Ayyangar, Dr. A. H. Pandya, Mr. S. Lall, Mr. Dharma Vira and Mr. John Sargent.

Sir Herbert Howard has been appointed Adviser to the Government of India on Forestry with headquarters at New Delhi. He will be succeeded by Mr. Simmons as President of the Forest Research Institute.

Prof. R. A. Fisher, the well-known statistician, has arrived in India to advise the authorities on the reorganisation of the Indian Statistical Institute at Calcutta. The Government of India have decided to reorganise this Institute by recognising it as a private body with legal status. Prof. Fisher's headquarters will be transferred to Delhi as soon as practicable. While in Delhi, he will advise the Government of India on statistical matters.

Professor Raymond E. Kirk, Dean of the Graduate School and Head of the Department of Chemistry, and Professor Donald F. Othmer, Head of the Department of Chemical Engineering, Polytechnic Institute of Brooklyn, have taken over the editorship of an *Encyclopedia of Chemical Technology*. This Encyclopedia will be published by Interscience Encyclopedia, Inc., and distributed by Interscience Publishers, Inc., New York.

Chemical products and processes as well as the equipment of the chemical industry will be described in considerable detail. An alphabetical arrangement will be followed and the articles will be signed by the contributors. The tentative plan provides for the publication of 10 volumes of approximately 900 pages each. The first volume is scheduled to appear in April 1946, and the tenth volume will appear in April 1949.

An editorial office has been organized in close proximity to the Polytechnic Institute of Brooklyn. Miss Janet D. Scott, formerly with "Chemical Abstracts" and the Calco Chemical Division, American Cynamid Co., will act as assistant editor in charge of this office. An editorial board is being selected.

Current American practice will be stressed in this work designed for American chemists and chemical engineers.

At the Annual General Meeting of the National Institute of Sciences of India, held on the 2nd January, 1945, at the Science College, Nagpur, the following were duly elected Office-bearers and members if Council, for the year 1945:—

President: Mr. D. N. Wadia; *Vice-Presidents*: Prof. S. P. Agharkar and Sir S. S. Bhatnagar; *Treasurer*: Rai Bahadur K. N. Bagchi; *Foreign Secretary*: Prof. D. S. Kothari; *Secretaries*: Rai Bahadur S. L. Hora and Dr. W. D. West; *Editor of Publications*: Prof. J. N. Mukherjee. *Members of Council*: Prof P. R. Awati, Dr. K. Bagchi, Dr. S. K. Banerji, Prof. H. J. Bhabha, Khan Bahadur M. Afzal Husain, Prof. M. O. P. Iyengar, Prof. P. C. Mahalanobis, Dr. K. G. Naik, Dr. B. N. Prasad, Dr. H. S. Pruthi, Prof. M. Qureshi, Mr. B. Rama Rao, Dr. L. A. Ramdas, Prof. P. Ray, Rai Bahadur J. M. Sen, Dr. A. C. Ukil, and Dr. K. Venkataraman.

MAGNETIC NOTES

Magnetic conditions during February 1945 were slightly more disturbed than in the previous month. There were 15 *quiet* days and 13 days of *slight* disturbance as against 19 quiet days, 9 days of slight disturbance and 1 day of moderate disturbance during the same month last year.

The quietest day during February 1945 was the 21st and the day of the largest disturbance the 15th.

The individual days during the month were classified as shown below:—

Quiet days	Disturbed days — Slight
1, 3, 7, 10–13, 18–22, 24, 25, 28.	2, 4–6, 8, 9, 14–17, 23, 26, 27.

No magnetic storms occurred during the months of February in 1944 and 1945.

The mean character figure for the month of February 1945 was 0·46 as against 0·38 for February 1944.

M. PANDURANGA RAO.

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THE FUTURE OF MYCOLOGICAL RESEARCH IN INDIA

MYCOLOGY touches upon a number of other sciences and in turn is influenced by them. Amongst the applied sciences in which it has long been of importance, first and foremost comes plant pathology, closely followed by soil science. More recently it has begun to play an increasingly large role in chemistry. It is of significance in human nutrition. In medicine, where it has hitherto taken a comparatively minor place, it has in the past three or four years loomed large. As a branch of botany the study of the fungi themselves has long been interesting and important because the fungi provided useful and comparatively easy material for the study of form, of physiology, of specific relationships, and particularly of sexuality, where it has been possible to observe processes taking place in small groups of cells under a high-powered microscope *in vivo*. The classification of fungi is unique inasmuch as they represent the largest group of living things which are classified mainly on the basis of micro-morphology. The result has at times been a tendency to place undue emphasis on minor morphological characters which has often led taxonomy into disrepute, but the realisation in recent years of the immense significance of fungi in a wide range of human activities has compelled the applied mycologist to return to the field of taxonomy with increasing energy and to devote to it a measure of time and skill which was hardly imagined a generation ago.

This diversity of activities of mycologists is to-day giving rise to certain serious and difficult problems of organisation. There is now a need for teams of skilled workers having a profound knowledge of the habits of fungi from entirely different points of view and with bearings on completely different problems. In plant pathology, the mycologist must have a deep insight of plant physiology, agronomy and taxonomy, accompanied by some understanding of both organic and inorganic chemistry, which is called upon constantly for the control of plant diseases by the use of chemicals and by other methods. In soil mycology, a subject sadly neglected in India, an understanding of soil physics and chemistry, as well as bacteriology, is essential. If the useful fungi are to be developed in India, it can only be possible by the collaboration of mycologists with biochemists and nutrition experts. In the realm of fungal therapeutics, there is need for skilled research workers possessing adequate and well-equipped laboratories for research on human and animal medicine, as well as first-class biochemists, all working in teams. Modern inventions of food processing, the fabric industries, leather, timber, and (in rapidly expanding measure) electrical equipment, are facing problems due to fungal damage of a very special nature, requiring a type of technological expert not known a few years ago. These problems would not be difficult to solve were it not for the fact that mycology is in itself a

separate science requiring wide knowledge and the ability to grasp the fundamental relationships of a great range of micro-organisms. The problem of organising research in mycology, is, therefore, one of co-ordinating the activities of specialists in a science who have to be distributed and carry on their work in a number of quite disconnected branches. It is, in fact, a problem of so directing the activities of a group of scientists that their services can be placed at the disposal of a number of unrelated sciences without their losing the unity which they must retain if the science of mycology itself is to advance. It is a problem of how to disperse and yet to integrate.

If anyone does not believe that this is a real problem, let him examine any well-known classification of fungi—that, for instance, of Saccarado, and then read one of the well-known works on medical mycology. If, after mastering the former, he is capable of comprehending the latter after one or even two readings, he will have proved himself to be indeed a master of multiple and confused conceptions. The classification and description and also the terms used to describe the same thing are often quite different; while frequently, on the other hand, the same terms, even the same generic names, are used to designate organisms or organs unrelated both morphologically and physiologically.

We may assume that the nature of the various kinds of work to which we have referred indicate clearly enough that specialist mycologists have to work along with teams of other scientists to which mycology is little more than a name. What we have to decide is the number and nature of the various kinds of specialist mycologists, the type of institution in which they will have to work and how the work of all of them can then be integrated so that unity of terms, conceptions and outlook can be maintained. The organisation and grouping of specialist mycologists proposed here is an attempt to solve this problem.

Plant Pathology

Plant pathology is one of the oldest and still the largest of the activities of mycologists. In India it is organised both centrally (at the Imperial Agricultural Research Institute) and provincially in the various agricultural departments. The earliest work was mere observation by workers in foreign countries on materials sent to them from India. The first pathological research of importance was that of Barclay in Simla. Early in this century work became centralised at Pusa, due, mainly to the outstanding achievements of Butler. With one or two notable exceptions there was little done provincially until Butler's students had become scattered over the provinces.

Pusa was fairly well situated for studying a considerable number of plant diseases. Many crops could be grown there including some which were more or less tropical in nature, although not those most characteristically so. Few, of course, of the diseases caused by the cool climate-loving fungi could be studied. With the removal of the Institute to Delhi, which has a rigorous climate of hot dry summers and rather cold winters, the number of crops which could be worked with was reduced, and even on those on which research was possible, it could be conducted only for a short period of the year. Work under controlled conditions of temperature is impossible apart from a few winter months. The conditions of climate are in fact such that only a dozen or so crops can be studied for any appreciable length of time during the year. The field could be greatly expanded by the addition of a suitable hill sub-station, but none has been provided.

What is true of Delhi is true of any place selected in India, though usually to a lesser degree. There is no one place where all crops can be grown. Plant pathological research requires dispersal on a provincial basis, according to crop geography. The work requires close association with experimental farms, and generally speaking can best be done by agricultural departments of provincial governments.

It is only as a result of recent research that we have appreciated the importance in Northern India of the Himalayas as a possible source of origin of epiphytotics. No province of India consisting mainly of plains with adjacent hills can ignore this possibility, and hill stations for plant pathological research must now be regarded as essential. The extent of India and the variation of climatic conditions as one proceeds from the dry mountains of the west to the eastern hills is such that one single hill station will not suffice. Several will be required.

Soil Science

The role of fungi in the soil received much attention at the beginning of the present century in many parts of the world, but not in India. It is a rather remarkable thing that in India, where the soil is low in humus, and where stress is being laid at the moment on green manuring and increasing the organic matter in the soil, little or no attention has been paid to the agents responsible for the first step in making available to plants the green matter which must be applied if the humus content is to be appreciably increased. Major drawbacks in both green manuring and composting are the conditions required to establish the decomposition and the long time required to complete it, which, in the case of green manures at any rate, is a severely restricting factor in its application. Methods that would induce rapid fungal activity in the early stages, whether by inoculation or by chemical treatment, are essential, yet we know little of the kind of fungi inhabiting Indian soils and next to nothing about their selective properties. Perhaps this is due to an overstressing of the chemical aspects of soil science. At any rate, the close association of mycologists with soil scientists seems to be essential if we are to see useful developments along this line. Much of the best soil science work has been done in our Universities,

and doubtless it will continue to be so. There is no reason why mycologists should not be attached to the soil science departments of all Indian Universities where this subject is taken seriously. Again, however, a very wide outlook and thorough experience of the fundamental aspects of mycology are needed.

Chemistry and Nutrition

In the applied branches of chemistry mycology can be of great assistance. At the present moment India is converting a large amount of molasses into alcohol, which is required for a number of industrial processes as well as for fuel. Whether alcohol as fuel for combustion engines can compete in normal times with mineral fuels is uncertain, but certainly there are other industries developing in India which will absorb considerable amounts. The alcohol industry of the country will not find it easy to hold its own under the competition to be expected in the post-war period. It is essential that production should be efficient, and that the maximum amount of alcohol be produced from a given quantity of carbohydrates. This is only possible if better biological control of the process is followed than is the case at present, where inoculation is largely a matter of chance and the selection and maintenance of suitable strains of yeast receives no attention.

There are other fermentation industries where mycologists are needed. Vinegar and acetone and acetic acid are often produced with little attention to the proper organisms; a citric acid industry, we believe, does not exist, though in other countries the mycological method of producing the acid has taken the place of natural citric acid from fruit.

In all the chemical industries, factories must be established where the raw products exist. Centralisation is impossible except for the more fundamental aspects of the work.

The fermentation methods of producing readily digestable proteins and of rectifying vitamin deficiencies are now receiving attention in India, as in other countries. The possibilities here are great and fascinating, but exploitation demands heavy capital expenditure and a high degree of biological control. Provided these exist, there is no reason why, after the war, large quantities of molasses, and possibly other crude forms of carbohydrates, should not be converted into food rich in protein and vitamin B, which are exactly what is required to rectify two major deficiencies in the diet of the masses. We are thinking at the moment in terms of waste molasses, but there is no reason to suppose that this is the only source of carbohydrate which will be sufficiently cheap for the purpose. Potatoes and some of our millets which yield well and of which these are in normal times surpluses in ceratin areas could likewise be used, but there are technical difficulties to be solved before this is possible. Provided food yeast can be profitably manufactured from molasses to start with, and the public can be educated to its use, it should be quite possible to extend production with the use of other crops. Food yeast production, if it succeeds in the early stages, may well follow the same course as many other fermentation industries, where the bye-product has become so important that it has eventually become the primary product.

Food yeast and yeast extracts may prove to be not only important nutritional aspects of fungi. Many edible fungi grow well under Indian conditions, *Volvaria diplasia* being one example. We have tended to regard fungi as of little importance nutritionally because of our disposition to regard the common English mushroom, *Psalliota campestris*, as the last word in edible fungi, although in many countries it is thought of as a second-rate edible form, and it is neither the most productive nor the simplest to cultivate. It is worth remembering that fungi are amongst the few organisms able to convert cellulose quickly into digestable carbohydrates.

The mycological problems of food yeast production (and they are many) will have to be worked out at factories, which will be located wherever there is a plentiful supply of molasses or other suitable carbohydrates. On the other hand, the cultivation of many fungi and the study of their nutritional value could be investigated quite well at a central place, and in practice is likely to remain a small-scale village industry. All stages of the research could well be done at a central agricultural institute.

Medicine

Originally important in medicine chiefly because of their poisonous nature, the value of fungi in pharmacy has been appreciated only during the past century in European countries, though doubtless going back many generations in China and other old civilizations. The production of the drug ergot, of which there is at present a world shortage, has received serious attention in South India, where it is being grown successfully on a commercial scale. Possibilities of the extension of ergot culture, the use of ergots indigenous to India, the risks involved in its culture, and possibilities of artificial culture, are matters deserving attention. Ergot production has to be done at places with a suitable climate, moderately humid and not excessively hot. The assaying and artificial culture can be done in any suitably equipped laboratories.

The most spectacular work in pharmacy in recent years has been the production of the drug, Penicillin. Its commercial production can now be exploited in well-equipped factories. There is much research work remaining to be done. The use of the drug for tropical diseases and the possibility of finding other drugs produced by fungi are specific problems to be worked on in well-equipped medical laboratories with the aid of skilled mycologists. It is the facilities for medical research which should be the criterian for selecting a suitable site for the work. A number of mycologists in India are investigating the problem, but there is some evidence to suggest that the objective

is not clear and that little more is being added to our knowledge than was already known from the work done in other countries. The best use is not, therefore, being made of the workers, who should be engaged on parts of the problem allotted to them by a co-ordinating authority.

Industrial Mycology

The mycology of fabrics, of foodstuffs, leather goods, plastics, insulating material, scientific equipment, and so on, has come to the fore especially during the war. It is a special branch of mycology requiring a thorough knowledge of the fungi commonly known as "moulds", a rather indefinite term covering certain Mucorales, some Ascomycetes such as *Aspergillus* and *Penicillium* and a large number of imperfect fungi of the Moniliaceæ and Dematiaceæ. While some of the work has to be done in factories and godowns, there seems to be no reason why, after the war, much of it should not be done in a central place which would have facilities better than could be provided by the numerous industries concerned acting individually. Such work could perhaps best be centred in one of the large manufacturing cities, and could be associated with a technological laboratory dealing with cotton, jute, or some other fibre.

Fundamental Mycology

All the aspects mentioned above have relation to specific major groups of problems. Each is connected with certain groups of fungi of a rather limited kind. In such work the danger is that the workers concerned will lose contact with other branches of mycology and will become narrow in their outlook, so that they will tend to overlook modern trends and remain unaware of the significance of findings by other branches which are of fundamental importance to their particular branch also. It is this narrowness of outlook, and its consequent limitation of scope and ideas, that has to be guarded against by giving proper attention to mycology itself, by which is meant the study of fungi for what they are themselves rather than for what is their importance to other sciences or to industry. A central research agency is required which can constantly have experts working on and monographing the various groups of fungi, recording their behaviour and their distribution in nature. Such an agency needs a particularly well-equipped library, first-class laboratories, a good herbarium and a national culture collection. The aim of the mycology section at the Imperial Agricultural Research Institute during recent years has been to build up such an organisation. It has meant a considerable change from the Pusa tradition which was built up, for obvious reasons, with an agricultural bias. Such a change in outlook was inevitable, for, as already pointed out, it could not deal with all, or even a major portion, of India's crop problems. Its facilities, however, are still inadequate, and a crying need is the establishment of a hill station where work can be carried out on the temperate fungi, many of which in all probability are carried yearly or occasionally to the hot plains during the cooler weather.

To summarise, we appear to need groups of mycological workers distributed more or less as follows:—

Plant Pathology: Agricultural experimental stations throughout India under the Government departments of Agriculture. *Soil Science*: Soil Science departments of the Universities. *Chemistry and Nutrition*: Factories, with a central laboratory for fundamental work attached to a nutrition laboratory. *Medicine*: A medical research institute. *Industrial Mycology*: In association with a technological laboratory dealing with fabrics. *Fundamental Mycology*: At a central research institute in association with other sciences and having access to a first-class library.

G. Watts Padwick.

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PROFESSOR P. C. MAHALANOBIS, F.R.S.

The happy announcement of the election of Professor Prasanta Chandra Mahalanobis to the Fellowship of the Royal Society, will be received with supreme satisfaction by his numerous pupils, colleagues and admirers. The distinction is a belated recognition of his pioneering, substantial and enduring contributions to the science of Statistics, in its pure and applied aspects. The Indian Statistical Society and *Sankhya*, its official organ, owe their inception to his genius, zeal and organising ability. By example and by precept, he has inspired and fostered a strong, flourishing and an internationally recognised school of statistical science in this country. On this auspicious occasion, we wish to tender to the Professor our heartiest felicitations and wish him a long career of greater distinction and achievement.

RELATIVISTIC EQUATIONS FOR PARTICLES OF ARBITRARY SPIN

By H. J. BHABHA, F.R.S.

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THE problem has often been formulated as to how far the equations for a relativistic particle of any assigned spin can be put into the form

$$(p_k \alpha^k + \chi)\,\psi = 0 \qquad (1)$$

where $p_k = ih \dfrac{\partial}{\partial x^k}$, χ is some arbitrary constant and the α^k's are four matrices which satisfy a different set of commutation relations in each case. It is well known that the equation (1) is invariant for all transformations of the Lorentz group if the α's satisfy the commutation relations

$$[\alpha^k, \mathrm{I}^{rs}] \equiv \alpha^k \mathrm{I}^{rs} - \mathrm{I}^{rs}\alpha^k = g^{kr}\alpha^s - g^{ks}\alpha^r \qquad (2)$$

where the metric tensor g^{kr} is defined by $kg^{00} = -g^{11} = -g^{22} = -g^{33} = 1, g^{kl} = 0, l \;, \neq$ and the $\mathrm{I}^{rs} = -\mathrm{I}^{sr}$ are the six infinitesmal transformations of a particular representation of the Lorentz group satisfying the commutation rules

$$[\mathrm{I}^{kl}, \mathrm{I}^{rs}] = -g^{kr}\mathrm{I}^{ls} + g^{ks}\mathrm{I}^{lr} + g^{lr}\mathrm{I}^{ks} - g^{ls}\mathrm{I}^{kr} \qquad (3)$$

The further equation

$$[\alpha^k, \alpha^l] = \mathrm{I}^{kl} \qquad (4)$$

can be shown to be consistent with (2) and (3) but it cannot in general be deduced from them. It should be noted that a possible numerical constant on the right of (4) can always be removed by absorption into the α's and results merely in a change of the value of χ in (1) which is without any significance.

I have investigated all possible equations of the form (1). It can be shown that these include a set equivalent to the one given by Dirac[1] and the alternative equivalent formulations in the force free case given by Fierz[2] for particles of any assigned spin. The necessary subsidiary conditions are not included. It also includes a set which is a generalisation to higher spins of the type of the scalar wave-equation. There are other more complicated sets. But I have proved that except for the case of spins 0, ½ and 1 equation (4) is not necessarily satisfied.

It can, however, be postulated that equation (4) shall hold for all spins. All the irreducible representations of the set of ten operators I^{kl} and α^k satisfying (2) to (4), *i.e.*, all possible irreducible wave equations of the form (1) can then be found by the following artifice. We introduce a new index 4 and define

$$\mathrm{I}^{k4} \equiv -\mathrm{I}^{4k} \equiv \alpha^k$$

$$g^{44} = -1, g^{k4} = 0 \qquad k \neq 4 \qquad (5)$$

The equations (2) and (4) are then included in the set (3) if we let the indices in the latter run from 0 to 4 instead of from 0 to 3. But the resulting ten matrices I^{kl} then satisfy the commutation rules for the infinitesimal transformations of the Lorentz group in five dimensions, and all irreducible representations of these are known. The problem is, therefore, completely solved. It can also be deduced immediately that the four α^k's and the six original $^k\mathrm{I}^l$'s have the same eigenvalues (possibly multiplied by i to allow for the time-like character of the first co-ordinate). For example, by (2) and (3) the three quantities I^{kl}, α^k and α^l for $k,l = 1,2,3$ satisfy the three equations

$$[\alpha^k, \mathrm{I}^{kl}] = -\alpha^l, \; [\mathrm{I}^{kl}, \alpha^l] = -\alpha^k,$$

$$[\alpha^l, \alpha^k] = -\mathrm{I}^{kl} \qquad (6)$$

which are just the commutation rules for the three components of angular momentum, and it follows from this that in any representation, irreducible or otherwise, I^{kl}, α^k and α^l have the same eigenvalues and satisfy the same characteristic equation. It can be proved further that for any irreducible representation the eigenvalues are always s, $s-1$, ... $-s+1$, $-s$ where s is any integer or half odd integer. One can define a particle of spin s as one for which the maximum eigenvalue of the I^{kl} is s. In that case more restricted commutation rules which the α^k's have to satisfy for a given value of s can be deduced from equations (2) to (4), as has been done by Madhava Rao[3] for $s = 3/2$ and $s = 2$.

The imposition of the condition (4) has very far-reaching consequences. It drastically cuts down the number of possible equations. The allowed set includes the Dirac equation and the scalar and vector Kemmer[4] equations, but it *excludes* the equations given by Dirac for particles of higher spin. The allowed equations for higher spins are such that each component of the wave-function in the force-free case does not satisfy the usual second order wave equation but a factorisable equation of higher order. To see this we note that since the α^k are matrices of a finite number of rows and columns, say n, the operator $\mathrm{P} \equiv p_k\alpha^k$ must satisfy a characteristic equation of order $\leqslant n^2$ whose coefficients can only contain products of the four quantities p_k multiplied by pure numbers. It can also be seen quite easily that this characteristic equation must be invariant for all transformations of the Lorentz group and hence must contain the p_k only in powers of the combination $p^2 \equiv p_k p^k$. To find the numerical coefficients we consider the special case when $\mathrm{P} = p_0\alpha^0$, the other three components of p_k being zero. Since the eigen-values of α^0 for spin s are $+s$, $\pm(s-1)$, ... it follows that the characteristic equation of P must be

$$\{\mathrm{P}^2 - s^2p^2\}\{\mathrm{P}^2 - (s-1)^2p^2\} \;\ldots\ldots = 0 \qquad (7)$$

the last factor being either P or $\mathrm{P}^2 - p^2/4$ depending on whether s is an integer or half odd integer. Our derivation shows that this is the lowest order characteristic equation that P can satisfy, for otherwise α^0 would also satisfy one of lower order. Letting this equation act on ψ and replacing every P in it by $-\chi$ through a repeated use of (1) we see that each component of ψ must satisfy the equation

$$\{\chi^2 - s^2p^2\}\{\chi^2 - (s-1)^2p^2\}\cdots$$

$$\{\chi^2 - p^2\}\chi\psi = 0 \qquad (8a)$$

if s is an integer, or

$$\{\chi^2 - s^2p^2\}\{\chi^2 - (s-1)^2p^2\}\cdots \{\chi^2 - {}^9/_4p^2\}\{\chi^2 - {}^1/_4p^2\}\psi = 0 \qquad (8b)$$

if s is half-odd integer. These equations show that a particle of spin s must necessarily appear with $2s$ and $2s+1$ values of the mass respectively, namely, $\pm\chi/s, \cdot \pm \chi/(s-1), \ldots$. Thus a particle of spin $^3/_2$ in this theory would necessarily be capable of appearing with two different values of the rest mass, the higher value being three times the lower. These higher values of the rest mass cannot be eliminated by an artifice any more than the states of negative mass (energy) in Dirac's theory of the electron, and we are, therefore, compelled to regard them as different states of the same particle. The above theory has the advantage over the theories of Dirac, Fierz and Pauli[5] that the equation (1) can be deduced naturally from a Lagrange function even in the presence of an electromagnetic field. There are no awkward subsidiary conditions.

1. Dirac, *Proc. Roy. Soc.*, A, 1936, **155**, 447–59. 2. Fierz, *Helv. Phys. Acta*, 1939, **12**, 3–37. 3. Madhava Rao, *Proc. Ind. Acad. Sci.*, A, 1942, **15**, 139–47. 4. Kemmer, *Proc. Roy. Soc.*, A, 1939, **173**, 91–116. 5. Fierz and Pauli, *Ibid.*, 1939, **173**, 211–32.

SCIENTIFIC RESEARCH AND INDUSTRY IN U.S.A.

By Sir J. C. Ghosh, D.Sc., F.N.I.
(*Director, Indian Institute of Science, Bangalore*)

THERE is an old Chinese saying that it is wiser to go abroad and learn than stay at home and teach. Accordingly we find that Chinese scholars for nearly a millennium, between the second century B.C. and eighth century A.D., came in large numbers to the famous universities of India, Taxila and Nalanda, staying there as long as they wished and seeing and learning whatever they wished to see and learn. The hazards of journey in those days were indescribable but where the spirit was daring, the flesh was never too week. The wheels of human progress move continuously and to-day have brought up to top the people of a country which only 300 years ago was a vast pathless jungle. We, from these ancient countries of India and China, cannot too often go to America and see for ourselves how the people there have shaped their lives and institutions which have enabled them to come to the forefront of progress. The Harvard University celebrated the ter-centenary of its foundation only few years ago. The Dean took us round what he called *the yard* of the University, round which the magnificent university buildings have been built. I asked him, "Why do you call it a yard and not a campus?" He said, it was the yard built by the Pilgrim Fathers with high walls all round, where they milked their cows and rested for night so that they might not be disturbed by ravenous wolves or red Indian poachers. The milk from the cows was fed straight to the children on the spot, and thus filled the need of a nursery school in the yard. That was the origin of the Harvard University. The few thousands of aboriginees there did not know that their problem of food and living could be solved in any way except by continuous wars of extermination between the tribes for small fields of maize or fishing grounds. Yet that country maintains to-day 150 millions of human beings with food, in such an excess that, some years ago, maize was burnt and milk thrown into streams to keep up the price level, with a standard of living so high that every family has a motor car of its own and perhaps two radio sets, one for the youngsters and the other for the elders, with one telephone for every eight persons, and with prophylactic and sanitary measures so perfect that the average expectation of life is sixty years. These have been achieved by the genius of the people in harnessing scientific knowledge for the development of the country. In Philadelphia, one cannot help admiring the statue of Benjamin Franklin on a long column which can be seen from miles; the central theme that he preached was that the most certain way of human betterment was improvement in natural knowledge. His countrymen have profited by this advice. They are making continuous efforts to learn the secrets of healthy living, to gain increased mastery over the force of nature, to make new materials having better qualities, to increase the productivity of the soil, and to improve the quality of crops and livestock by scientific breeding and management. All the Research Laboratories have one motto—"The impossible is only what we have not learned to do" and "what is impossible to-day will be commonplace tomorrow."

I believe it will be of more human interest if I were to touch lightly upon the activities of some of the institutions that we visited so that one may draw one's own conclusions regarding American enterprise in research. We visited, among other institutions in Washington—Bureau of Standards where the genial Dr. Lyman Briggs directs the activities of a magnificent group of workers. The average annual expenditure is about 3 million dollars. As a chemist, I was specially interested in the work of Rossini, who has practically revolutionised the technique of separation of hydrocarbons by fractional distillation. His long glass columns, often 60 feet high, give cuts whose boiling-points are constant within one-hundredth of a degree. Physico-chemical properties of these hydrocarbons were being studied with the greatest accuracy—their heats of combustion, free energies, specific heats, etc. This fundamental work is being undertaken because of a conviction in America that synthetic organic chemistry of the future will be based on the hydrocarbons of petroleum and natural gas. The Union Carbide and Carbon Corporation which has now absorbed the American Solvents Corporation, The American Cyanamide Company and the Bakelite Corporation, is now a giant chemical combine which has done pioneering work in this field, *e.g.*, in the chlorination of hydrocarbons, in the preparation of vinyl and acrylic resins, in the

manufacture of polyethylene insulating films and sheets, in improvements in the manufacture of power alcohol from ethylene, etc. I was told that polyethylene films, because of their incredibly high dielectric strength, will be *the* insulating material in future electric machine construction and will make possible enormous reduction in the size of electrical machinery without affecting their H.P. The improved polyvinyl acetal resin is exceedingly strong and elastic; can be sandwiched between two sheets of glass without any other adhesive, requires no edge sealing, retains its elasticity at low temperatures with the result that any object striking the glass rebounds rather than penetrates. We were shown films impervious to air, and so strong that air-cushions made by enclosing air within two film surfaces and sealing off the edges by simple heating could easily carry our weights without bursting.

I was interested to find that even the Bureau of Standards under the stress of the war has become a manufacturing concern; the Indian Institute of Science is not the only culprit in this respect. They are the biggest producers of optical glass in U.S.A. in war time. Dr. Bates, the Head of the Glass and Ceramics Division, showed us all the details of manufacture and informed us that annual production now amounted to about 2 million dollars. I wish I were a glass technologist capable of taking a more intelligent interest in the details of the process with a view to their adoption in glass works in India. While talking of glass, I may mention that in addition to shrunk glass made by Corning Glass Works, which has the properties of quartz, there have been two notable developments in glass technology:—one is glass without silica, transparent tubes of which were shown us at the Carnegie Institute of Technology, Pittsburg, and the other, glass fibre with surprising properties, capable of being easily woven. Glass-fibre clothes are being extensively used in filtering strong acids—*e.g.*, it is the only material used in filtering TiO_2 from sulphuric acid mother-liquors. Very thin fibres are now available in many colours and as a non-inflammable and enduring fabric it is pushing its way in competition with linen and cotton for draperies and table covers, and in the electrical industry, as competitor against asbestos.

Another institution which we visited in Washington is the Headquarters Research Station in Bestville Farm of the Bureau of Agriculture. I was told of the work that was being done on nitrogen fertilisers. In all the belligerent countries, ammonium nitrate will be in excess supply after the war. It is a very good fertiliser but its water-absorption capacity stands in the way of its use. Waterproof bags, coating of the nitrate crystals with resins, are some of the lines of attack on which intensive work is being done. But the best work that has been done in U.S.A. is in the production and trial of urea as fertilisers. We in India now are using ammonium sulphate. The sulphate radical is not injurious in calcium-saturated soil, but increases the acidity of laterite soils, where its continued application is fraught with danger. Urea is much less acid-forming than ammonium sulphate and contrary to common belief, is as resistant to leaching as ammonium sulphate. Dr. Parker, the Chief Soil Chemist to the Bureau of Agriculture, is definitely of the opinion that urea is the nitrogen fertiliser of the future, specially in countries like India, which have no deposits of sulphur or gypsum near its coal fields. We were told that urea containing 44 per cent. nitrogen is now being manufactured by Dupont, about 200 tons a day at $5,000 a ton, *i.e.*, at Rs. 165, whereas the anticipated cost of production of ammonium sulphate containing 21 per cent. nitrogen at a factory at Dupont, about 200 tons a day at $50 a Rs. 119 per ton. This excessive cost is due partly to freight charges of gypsum from Rajputana and Punjab fields to the coal fields of Bihar. Our agricultural planners envisage expansion of the ammonium sulphate industry to 2 million tons in 15 years; they will be well advised to plan the production of one million ton of urea instead.

From Washington we went to Pittsburg—the centre of America's Coal and Iron Industry—and were very cordially received by the authorities of the University and the many Research Institutions for which Pittsburg is justly famous. Closely associated with the University is the Carnegie Institute of Technology, which is very well equipped for purpose of teaching and research on metallurgy, ceramics and fuels. There are also in the neighbourhood, the laboratories for researches on coal maintained by the Bureau of Mines which is a department of the Federal Government. The biggest manufacturers of coke-oven-gas, and coke oven plant in U.S.A., Koppers, Ltd., have also their research laboratories there.

Then we have the Mellon Institute whose magnificent laboratories, built in 1937, set up a new standard even in America. This Institute was founded in 1911. The two brothers, Andrew and Richard Mellon, felt that their vast wealth could not be better used than by establishing a Research Institute which will help manufacturers who have little research facilities of their own, to develop new products or improve old processes. Such an Institute will be a strong force in the direction of improving the standard of living through discoveries and inventions. Then, out in the suburbs, are located the famous Westinghouse Research Laboratories which, in reputation, stands only second to the Research Laboratories of the General Electric Company at Schensctady. They have now in Condon one of the ablest physicists of the world to guide their research activities. And about fifteen miles from the city, are the laboratories of the Gulf Research Company where fundamental work is being done in geophysical methods of prospecting for oil, on lubricants and mechanical engineering problems associated with the use of liquid fuels and on the decomposition, polymerisation, isomerisation, cyclisation of paraffin hydrocarbons. The capital cost in building and equipment of each one of these laboratories is of the order of 7 to 10 million dollars, *i.e.*, 2 to 3 crores of rupees, and the annual recurring expenditure is of the order of 2 to 5 million dollars, *i.e.*, 75 to 150 lakhs of rupees. We often asked the question: Does it pay to spend such sums of money on research? We were told that an

industry that had been brought into existence with the aid of scientific knowledge could not hope to survive in a competitive world if not continually improved upon by new inventions. A forward looking executive always employs research to meet new competition, to avoid surprises which otherwise might seriously jeopardise his business and to prevent being placed at a great disadvantage should others come to know more about his business than he does himself. We were assured that research paid a handsome dividend, research sections are even more paying than actual operational sections. I am not able to speak with confidence about researches relating to an Electrical Industry, to metallurgy and geophysics in the Pittsburg area, but a few examples may interest you. We were shown a 5 million volt atom smasher of the electrostatic type which will be as powerful a tool for studies of nuclear physics as Cyclotron has been till now. We were shown the new device for producing powerful short-wave radio beams based on the properties of Magneton. We were also shown new and valuable alloys—one having the same coefficient of expansion as hard glass—covar, one possessing great strength at high temperatures which may be useful in high temperature gas turbine, a permanent magnet not more than six inches in diameter which I could not pull out from a steel joist. We admired a very rugged but an exceedingly sensitive instrument for measuring gravity within one part in ten million. Such an instrument can be placed in a lorry and accurate gravity surveys made of any area believed to be rich in mineral resources. I may give a practical illustration. On our way to England we rested for a night in the modern air port of Bahrein Island off the Coast of Arabia in the Persian Gulf. A few years ago it was only a fishing village inhabited by a few poverty-stricken Arab fishermen. I was told that it was included in the prospecting concession of the Anglo-Iranian Oil Company. The older methods of geological prospecting for oil by surface indication did not give much promise of a rich oil field below and the concession was surrendered. But the Americans came later on the scene and their newer geophysical methods predicted rich deposits of oil at great depths. It is well known that large salt deposits under the earth in the form of a dome are generally associated with deposits of mineral oil. Salt has a specific gravity which is less than that of sand and rock which form the earth's crust and its underground existence is often indicated by a diminution in the value of "g". There are other geophysical methods of confirmatory value, *e.g.*, records of seismic waves produced by detonating an explosive at the bottom of a deep hole reflected from various strata underneath, earth currents, etc. Their prediction proved true, and Bahrein Island is now a busy industrial centre producing and refining large quantities of petroleum and the Sheik of Bahrein is no longer a petty medieval landlord but an influential industrial magnate and I hope, a wise modern ruler. The 1,300 miles of air route from Bahrein to Cairo pass through the most inhospitable country of the world—North Saudi Arabia—with no sign of vegetable or animal life anywhere. But we were assured by the Director of the Gulf Research Laboratory that this desert highway will soon be a strategic highway of human civilization. They have discovered an oil-field there, 200 square miles in extent, which contains more oil than the two American Continents—every acre can have a well which will produce 10,000 barrels a day for 80 years. No hole has yet been drilled, but the oil is there as certain as the Sun rises in the East. Plans for building a long concrete channel to bring water from the Mespot rivers to this area are in progress and the survey of a pipe line which will link this field with Mediterranean on one side and Persian Gulf on the other has been completed. This field, now a part of the barren desert, will perhaps witness the rise of some of the richest cities in the world—air-conditioned factories, offices, and homes, with gardens all round. Similar garden-cities will also spring up at strategic points all along this pipe line through the desert. It will be one of the greatest triumphs of human skill and enterprise over adverse nature. Its influence on Indian economy is obvious. Cheap mineral oil will completely transform the methods of power production and furnace construction in the Western Coast of India which will be able to dispense with Bengal coal for such purposes.

One of the main problems of applied chemistry research in the Pittsburg area, relates to the devising of new instruments and apparatus which will place more powerful tools in the hands of industry. I found a team of physicists, physical chemists and mechanics engaged in designing and erecting a mass spectrograph which will give an automatic record of the relative proportion of the particles of different masses that may be present in the discharge chamber. I wondered what on earth would be the industrial advantage of such an instrument. I was told that the analysis in the field of gases that are obtained from different deposits when holes are drilled give valuable indication of the composition of rocks there, and any increase in the proportion of heavy hydrocarbon gases as the drill goes down is an indication of neighbourhood of oil deposits. Again, ordinary methods of hydrocarbon gas analysis which will give, say, the relative proportion of C_{10} and C_{9} molecules are extremely difficult, inaccurate and time-consuming; and such an automatic mass spectrograph will do in three hours what thirty chemists might achieve in thirty days. The control of catalytic hydrocarbon reactions by analytical checks will be ensured by this remarkable instrumental development.

The chemical departments of the University and the Mellon Institute were largely absorbed in researches on synthetic rubber, resins, and plastics. They were mostly war secrets but I could gather that the investigators were studying the properties of polymerising and modifying agents with a view both to accelerate and control the process of polymerisation; they were also studying the possibility of manufacturing diamines and polybasic acids from petroleum hydrocarbons. Beneficiation of ores was another subject which was receiving considerable attention. The newer sink and float

method for concentration of ore is being applied for treatment of iron ore and coal.

But the two branches of research which overshadow every other activity here were researches on coal and petroleum hydrocarbons. One cannot help noticing the remarkable improvement in design of coke-oven plants by Koppers, Ltd. I saw their most up-to-date plant in New York which handles 1·5 million tons of coal per year, the ovens heated by an auxiliary producer gas system, labour-saving devices on the sealing of doors, careful heat balancing to such a nicety that the basement under the oven can be used for office work, handling of coke oven gas, benzene, toluene, naphthalene, anthracenes, tar, asphalt, by semi-automatic equipment with the result that about seventy men work in the factory starting from transference of coal from the ships to the disposal of final products. Mention may be made of researches on the identification of the primary constituents of coal, on Bergius process of coal tar hydrogenation, on complete gassification of low grade coals by treatment in retorts of special design and special corrosion-resistant material, on production of industrial chemicals like benzene, dicarboxylic and tricarboxylic acids by the oxidation of coal at low temperature and high pressure of oxygen in presence of alkali, on Fischer-Tropsch process using the modern fluid flow catalyst system, etc.

A solid catalyst used in a gaseous reaction often gets inactivated and requires to be regenerated. In industrial practice, we have two reactors containing the stationary solid beds of catalysts connected together by pipes and valves and so worked that, while the desired chemical reaction is being carried out in one reactor, the catalyst bed is being regenerated by suitable treatment in another. This discontinuous alternate process was a question mark to the research staff of the Standard Oil Company and after years of intensive work and by tying together all the work on powdered catalyst they hit upon the idea of keeping the pulverised solid catalyst always suspended in oil vapours, air or steam, as the case may be, and continuously moving it from where it did its catalytic work to where it was cleaned and back to the reactor by regulating at each point the pressure of the suspending gas phase and hence the speed of the catalyst particles. In May 1942, construction of a commercial plant on this basis was started and today 32 fluid catalyst plants are operating with a daily productive capacity of 300,000 barrels of 100 octane gasolene. The American Chemical Engineers predict that within a decade after the war very few chemical reactions will be permitted in industrial practice to take place on a stationary bed of solid material acting either as a reactor or as a catalyst. It will bring about a revolution in many types of chemical plant design.

I regret it will take hours if I were to talk about our visit to other cities and laboratories. American business executive are imbued with the idea that research is the *elixir of life* of an industry, ever keeping it young and vigorous. They think that it is ignoble parasitism to have to depend upon others for up-to-date technical knowledge. They recognise further that the advantage that comes to industry from scientific knowledge comes mostly from the early use of such knowledge and from contact with men who have created such knowledge. How different is the attitude from that of an average industrialist in India who thinks that all that is necessary for the industrialisation of India is to import from abroad plant and machinery and also technical talent for running such plants for, say, ten years and train up our men in the mean time to take the place of foreign experts. They forget that in these days of rapid progress their plant and process may become obsolete in ten years. I wish they may receive better advice and see more light.

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BIOLOGICAL REACTIONS: SPECIFIC, GROUP AND NON-SPECIFIC REACTIONS, AND THEIR SIGNIFICANCE IN EVOLUTION

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WHAT THEY ARE

A FOREIGN protein, ANTIGEN, introduced into a living animal otherwise than through the alimentary canal, PARENTERALLY, produces a substance, ANTIBODY, in the blood. The antibody reacts with the antigen in the test tube, *in vitro*, and in the living body, *in vivo*, in several ways. These reactions are called BIOLOGICAL REACTIONS. As the antibodies are found in the serum, the reactions are also called SEROLOGICAL REACTIONS. Further, as the reactions usually produce resistance or immunity in the body against the foreign proteins (usually the bodies of infecting micro-organisms), they are also called IMMUNOLOGICAL REACTIONS. Briefly, they are antigen-antibody reactions.

The easiest to perform and one of the most sensitive *in vitro* biological reaction is the PRECIPITIN REACTION. A soluble antigen injected into the body produces in the serum PRECIPITIN which produces a precipitate with the antigen. The potency, TITRE, of the precipitin (containing) ANTISERUM is measured by the highest (weakest) dilution of the antigen capable of causing a precipitate. It is usually of the order of thousands. The titre of the antisera used by the writer in detecting the source of blood in a bloodstain is of the order of 1 in 40,000, *i.e.*, it is precipitated by a 1 in 40,000 dilution of the foreign serum. In such a dilution the protein cannot be detected by chemical tests. The biological reactions are, thus, seen to operate over a wider field than chemical reactions.

There are other *in vitro* reactions like COMPLEMENT FIXATION, exemplified by the well-known Wassermann reaction, which detect diseases in the system. This antigen-antibody reaction needs the intervention of

COMPLEMENT (a serological constituent, as opposed to a chemical constituent) which exists naturally in all fresh blood and *completes* the reaction.

NATURAL antibodies (as opposed to IMMUNE antibodies formed after injections) also exist. Bird's serum clumps, AGGLUTINATES, mammalian red blood corpuscles, rbc, by virtue of a natural AGGLUTININ.

Natural antibodies exist even against other members of the same species, ISOANTIBODIES. On such isoantibodies, ISO(HÆMAGGLUTI)NINS, depend the four blood groups previously discussed in this *Journal* (GREVAL, 1940).

Isoantibodies are also formed as a result of injecting bloods. The recently discovered Rh constituent of the human rbc is thus manifested (GREVAL, 1943).

In vivo biological reactions operate over still wider fields. In ANAPHYLAXIS the uterus of a guinea-pig previously injected with a foreign protein, SENSITISED, contracts in a 1 in 10 million solution of the foreign protein (McINTOSH, 1931).

Precipitin Reaction Taken as a Type

In this communication only the precipitin reaction will be considered. It was employed in a monumental work on the phylogenetic relationship of the mammalia (NUTTAL, 1904) and is employed to-day in tracing the origin of bloodstains in medicolegal work. The latter responsibility has probably made the study of this biological reaction by immunologists more critical than that of any other. It would pay biologists also to apply the present-day standardised techniques to the old problem again. It appears that a hundred per cent. biologist does not interest himself in biological reactions at all. Immunologists devise, refine and even apply them to his problems.

Specific Precipitin Reaction

Antihuman precipitin serum is prepared by (*i*) injecting a fowl intravenously with 3 c.c. of pooled normal human serum, (*ii*) bleeding the fowl to death under an anæsthetic ten days later and (*iii*) collecting the straw-coloured fluid from the clotted blood. All operations are performed with cleanliness and without pain. The antiserum is first tested for SENSITIVENESS: (*i*) a 1 in 1,000 dilution of normal human serum, when superimposed on the antiserum, should form at the junction of the two fluids a white ring *frank* in 2 minutes and *sharp* in 10 minutes; (*ii*) a 1 in 20,000 dilution should form a ring *dubious* in 10 minutes and *frank* in 20 minutes; (*iii*) a 1 in 40,000 dilution should form a ring which is dubious in 20 minutes. Then it is tested for SPECIFICITY: It should not react with a 1 in 1,000 dilution of normal sera from (*i*) buffalo, (*ii*) dog, (*iii*) horse and (*iv*) sheep and with a dilution of the order of 1 in 1,000 made from the dried blood of a monkey, in a stain of monkey's blood (by extracting the stain with normal saline and comparing its foam with that of 1 in 1,000 dilution of normal human serum). The sera passing the two tests are fit for use. They will detect the presence of human blood in the merest speck of blood.

Antisera for detecting the blood of animals are prepared and tested in the same way. The antiserum for testing the blood of a fowl is prepared in a rabbit which need not be bled to death. Its titre is not so high (1 in 1,000, 1 in 5,000 and 1 in 10,000 dilutions replace the other dilutions in the test for sensitiveness) and several injections may be required.

Group Specific Precipitin Reactions

1. *Human and monkey sera.*—Fresh monkey serum reacts with the antihuman serum almost like a human serum. On drying, its reaction is weakened rapidly. Of a dried stain of monkey's blood there is no risk whatsoever of being mistaken for a stain of human blood. The same observations apply to a reaction of human serum with an anti-monkey serum.

2. *Sheep and buffalo sera.*—When fresh they react almost alike with their antisera. Sheep serum and buffalo serum react with either antisheep or antibuffalo serum to the same degree. On drying the reaction weakens but not to the same extent as in the case of man and monkey. A distinction can only be made by timing of the appearance of the ring and by serial dilutions of the extract.

3. *Sheep and cow sera.*—The reaction is similar to the last reaction.

4. *Goat and buffalo sera.*—The reaction is similar to the last reaction.

5. *Goat and cow sera.*—The reaction is similar to the last reaction.

6. *Buffalo and cow sera.*—The distinction cannot be made with certainty.

7. *Sheep and goat sera.*—The distinction cannot be made with certainty.

The conclusion is obvious that in blood relationship man and monkey are more widely separated than sheep and buffalo/cow or goat and buffalo/cow, and much more widely separated than sheep and goat or buffalo and cow.

Non-Specific Precipitin Reactions

In the laboratory parlance when an antihuman serum fails in the test for specificity (begins to react with sera not used in its preparation and not coming from other animals in the same group) it is said to have turned polyvalent. It reacts with dog's serum for certain and with the sera of other unrelated animals occasionally. An opposite occurrence with respect to the anticanine serum was noticed many years ago: "It is worthy of note, that the tests made with the three preceding sera for carnivora (anticat, antihyæna, antidog—S.D.S.G.) agree in causing a larger proportion of reactions amongst the Primates than amongst any of the other mammalia, excepting the results with antihyæna serum which shows a large proportion of faint reactions amongst the Ungulates" (NUTTAL, *loc. cit.*). The question arises whether these reactions are indicative of a remote phylogenetic relationship and a diphylectic origin of the primates. Such an origin for the monkeys has been suggested on anatomical grounds alone (THOMSON, 1929).

The writer, further, finds that the antihorse serum also behaves like the antihuman serum in turning polyvalent and reacting with dog's serum. Of the opposite occurrence he has no

experience. The question, however, again arises whether the horse and the dog are more closely linked in blood than they appear to be on anatomical grounds.

Furthermore, the unconditional surrender of the dog and the horse to man may have a deep-seated biological basis. On the other hand, the irregularities in the formation of antibodies in response to the stimulus of a violent assault by a foreign protein on a living substance may be merely an outburst of vital potentialities, having no connection with the blood relationship whatsoever. Such an outburst may be a vital feature and must have also occurred when *one* life born in abiogenes became *many* in biogenesis and laid the foundations of the phyla; after the first rain had fallen on the then newly cooled virgin rock and dissolving countless crystalloids had carried them downstream to make a sea; after the crystalloids during their mixture and interaction had produced colloids; after one of the colloids had found itself *alive*; in the remote past under physical conditions different from those prevailing now; when the newly born life was twisting, turning and undergoing variations very rapidly to establish itself and to ward off the attacks of the cosmic ray which also was young and more potent than it is to-day.

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MICROBIOLOGICAL ASSAY OF THE OVERALL POTENCY OF GROWTH-FACTORS OF SHARK LIVER EXTRACTS

BY

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LIVER is reputed to constitute one of the richest sources of the B-complex, the anti-anemic principles and other unidentified growth-factors. Williams *et al.*,[1] in their study of pantothenic acid, used liver as the starting material. Kuhn and Wieland[2] have shown that tunny fish liver contains the same active principles as those which characterise mammalian livers.

With the development of the shark liver oil industry in India, appreciable quantities of liver residues are, at the moment, available at various centres of the industry. It was, therefore, of interest to make a systematic study of this potentially useful bye-product, with special reference to its content of the B-complex. The present communication deals with a microbiological assay of the overall potency of the growth-factors of the liver extracts as revealed by the response potentiated by varying doses of the extract towards a strain of *Lactobacillus* (Culture No. 3, N.C.T.C.: 2078).

RESEARCH MATERIAL

The three commercially known varieties of sharks generally worked up for their oil were selected for the investigation. Table I gives data regarding the contents of their oil and its vitamin A value as determined by one of us (I. M. G.).

TABLE I

Zoological Name	Local Name	Oil content per cent.	Vit. A in I. U./gm.
1. *Carcharinus melanopterus*	Khada (K)	50·7	55600
2. *Galeocerdo tigrinus*	Waghbeer (W)	70·0	4700
3. *Carcharinus limbatus*	Pisori (P)	40·9	9700

PREPARATION OF EXTRACTS

The liver residue (100 gms.) in each case was treated with 100 ml. of water and the mash digested at pH 5·5 with activated papain (5 gms.) at 40° C. for 48 hours. The digest was filtered, pH of the filtrate adjusted to 4·5 with acetic acid, steamed for an hour and the precipitate filtered off. The pH of the filtrate was carefully readjusted to 7·0 with 10 per cent. sodium hydroxide. The extract was afterwards distributed into 10 ml. ampoules which after sealing were sterilised at 15 lbs. pressure for 20 minutes. In the case of the extract from sheep's liver, digestion with papain was preceded by autolysis at 30° C. for 48 hours. For comparison, Lily liver extract (I.U.S.P. unit/ml.) was employed as the standard.

TABLE II

Liver extract	Milligrams per milli litre of extract			Complexity
	Total solids	Total N	Amino N	
Lily (L)	151·0	15·6	3·24	4·81
Sheep (S)	330·0	28·6	9·12	3·13
Khada (K)	115·2	16·0	4·51	3·55
Waghbeer (W)	111·0	12·9	3·98	3·24
Pisori (P)	119·5	16·8	3·48	4·82

SELECTION OF THE ORGANISM AND THE PREPARATION OF THE INOCULUM

The organism (*Lactobacillus*, strain No. 3, N.C.T.C.: 2078) employed for the microbiological assay, was obtained from the National Collection of Type Culture, India, Indian Institute of Science, Bangalore. Consequent to a comprehensive study of the nutritional requirements of the lactic group of organisms in the National Collection, this strain was found to give the maximum response to most of the vitamins of the B-complex so far examined.

Stab cultures of the organisms were carried in liver extract.—Pentone, glucose, agar (3 ml. 100 ml., 0·5 per cent., 1 per cent., 1·5 per cent.). The method of preparing and carrying cultures were those described by Snell and Strong.[3]

Inoculum for assay tubes was prepared by transfer from the stock culture to a sterile tube of basal medium to which sheep liver extract was added (3 ml./100 c.c. of B.M.). The inoculum was incubated at 37° C. for 24-36 hours before use.

Basal Medium

A simple synthetic basal medium (B.M.) was selected and is a modification of that used by Snell and Strong,[3] for the determination of riboflavin, and by Pennington, Snell and Williams[4] for the determination of pantothenic acid. It contains acid-hydrolysed casein (vitamin and fat-free) 0·5 per cent., tryptophane 0·01 per cent., *l*-cystine 0·01 per cent., glucose 4·0 per cent., sodium acetate 2·4 per cent., and inorganic salts. The constituents are prepared and preserved as follows:—

Acid-Hydrolysed Casein.—50 Gms. of vitamin and fat-free casein (B.D.H.) were hydrolysed with 260 ml. of 25 per cent. H_2SO_4. The mixture was autoclaved for 10 hours at 15 lbs. SO_4-ions were removed with $Ba(OH)_2$ and any excess Ba-ion was carefully removed with the minimum amount of H_2SO_4. The solution was adjusted to contain 100 mg. of dry matter per ml. It was preserved under toluene. Traces of vitamins were effectively removed from the casein hydrolysate with 10 mg./ml. of 'Norit' at pH 3·0.

Tryptophane and Cystine.—Stock solutions of tryptophane and cystine hydrochloride containing 1 mg./ml. were prepared and kept under toluene.

Inorganic Salts.—Solution A contains 25 gms. of KH_2PO_4 and 25 gms. of K_2HPO_4 dissolved in 250 ml. of water.

Solution B contains 10 gms. of $MgSO_4.7H_2O$, 0·5 gm. of NaCl, 0·5 gm. of $FeSO_4.7H_2O$ dissolved in 250 ml. of water. Five drops of concentrated HCl were added to stabilise the solution. 0·5 Ml. of soltion A and 0·5 ml. of solution B contain the requisite inorganic salts for 100 c.c. of basal medium.

Assay Procedure

A medium having 2·5 times the concentration of the basal medium was prepared, pH adjusted to 6·8 and 2 ml. of this medium were transferred into each assay tube. Graded doses of liver extracts corresponding to 0·021, 0·42, 0·083, 0·208, 0·417, 0·625, 1·25, 1·875, 2·5, 3·0, 3·75 and 4·25 mg. of nitrogen were added and in each case, sufficient distilled water added to bring the final volume in each tube to 5 ml. Duplicates and a blank were run for each concentration. The tubes were sterilised at 10 lbs. for 30 minutes, twice at an interval of 24 hours. Three loops of the inoculum were inoculated into each assay tube and incubated at 37° C. for 72 hours. The acidity produced during this period was directly titrated against 0·1 N NaOH to pH 6·8-7·0 using bromthymol-blue as indicator. Results are given in Table III and are also graphically represented (Fig. 1).

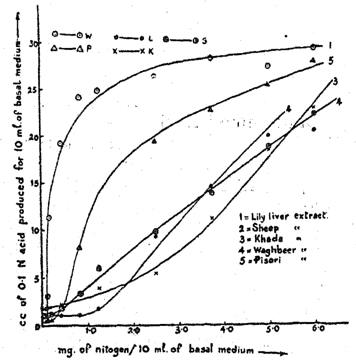

FIG. 1. Responses of N.C.T.C. 2078 to Liver Extracts

A close study of Table III and Figure 1 will reveal that, the Lily liver extract, per milligram of nitrogen potentiates the maximum response. Next in order comes the liver extract of Pisori, which, from the nature of the curve may be suspected to have a vitaminic make-up closely approximating to that possessed by the Lily liver extract. In other words, the functional similarity of the two extracts as revealed by the curves (see Fig. 1) suggests that Pisori liver might constitute a rich source of the antianæmic principles. The extracts from the livers like Khada and Waghbeer exhibit comparatively poor potencies; sheep's liver extract, however, gives a steady and linear response for the entire range of concentrations studied.

The minimal concentration of the extract (in terms of total nitrogen) at which the potency of the extract tends to get abolished is different for each of the extracts. These critical

TABLE III

Results expressed as ml. of 0·1 N acid produced for 10 ml. of basal medium

Liver Extract	Concentration of extract in mg. of nitrogen in 10 ml. of basal medium												
	0·042	0·083	0·125	0·167	0·417	0·834	1·250	2·500	3·750	5·00	6·00	7·50	8·50
Lily	1·1	1·1	3·1	11·3	19·3	24·1	24·7	26·3	28·0	27·2	29·0	32·1	34·3
Sheep	1·0	1·0	1·0	1·0	1·8	3·4	5·1	9·8	13·8	18·6	22·0	26·8	29·7
Khada	1·2	1·2	1·5	1·9	2·2	3·3	3·9	5·4	11·2	18·4	22·6	24·1	27·9
Waghbeer	1·1	1·1	1·1	1·1	1·1	1·1	1·8	9·4	14·5	19·9	20·3	22·5	29·7
Pisori	0·4	0·4	0·4	0·4	1·8	8·2	14·2	19·3	22·6	25·2	27·6	29·5	32·7

concentrations which are underlined in the table (Table III) represent the point below which the growth-factors, singly or severally, attain their respective limiting concentrations. It is interesting to observe that this limiting concentration is reached at the lowest nitrogen level (0·125 gms.) in the case of the Lily liver extract while in the case of Waghbeer liver extract the point is attained at a higher level of nitrogen (1,250 mgms.). The other extracts, including that of Pisori, exhibit loss of potency at a level of nitrogen corresponding to 0·417 milligrams.

It can also be noted that the response to the addition of the next higher concentration of the extract (higher than the critical concentration) is usually quick and substantial, particularly in the case of Lily and Pisori extracts.

The limiting concentrations of nitrogen may roughly be taken to be inversely proportional to the degree of purity of the extracts with respect to the growth-promoting factors. The potency and purity of the extracts may also be computed from the levels of nitrogen at which a given response is potentiated. For example, a response equivalent to about 10 ml. of decinormal alkali is given by 0·150 mgm. of Lily extract, 2·5 mgms. of sheep's, 3·7 mgms. of Khada's, 2·9 of Waghbeer's and 0·95 of Pisori's (computed from the curves, see Fig. 1). Taking Lily liver extract as containing 100 units of overall potency, the potencies for the extracts of sheep, Khada, Waghbeer and Pisori respectively work out as 6, 4, 5 and 16.

It has previously been suggested that the critical limiting value may have been reached with respect to a single or a multiple vitamin factor. With a view to elucidate this point, experiments were conducted, each of extracts being employed at the respective limiting level of nitrogen. Crystalline vitamins, thiamin, riboflavin, niacin, pyridoxine, calcium pantothenate and inositol were tried. Results are given in Table IV.

TABLE IV

Medium	Ml. of 0·1 N Acid produced for 10 ml. of B. M.		
	Khada	Waghbeer	Pisori
1. B. M. + L. E. + all vitamins	17·2	15·2	12·0
2. B. M. + L. E. + all vitamins except thiamin	15·7	14·1	11·0
3. B. M. + L. E. + all vitamins except riboflavin	8·4	14·0	10 6
4. B. M. + L. E. + all vitamins except Pyridoxin	17·4	15·5	10·6
5. B. M. + L. E. + all vitamins except Pantothenate	12·6	4·4	5·5
6. B. M. + L. E. + all vitamins except niacin	17·6	15·5	12·0
7. B. M. + L. E. + all vitamins except inositol	17·6	15·5	12·0

B.M. = Basal Medium; concentration of the vitamins used for each of the assay tubes was as follows:—Thiamin 0·5 γ; niacin 0·5 γ, calcium pantothenate 1 γ, riboflavin 1 γ, pyridoxine 0·5 mgm. Liver extract (L.E.) added = the limiting level of nitrogen as indicated in Table III.

Figures given in Table IV are highly significant; they suggest that the limiting concentration is reached mainly with respect to one of the vitamins. Khada lacks riboflavin mainly while pantothenic acid appears to be lacking in the liver extracts of Waghbeer and Pisori. The potencies of the extracts can, therefore, be effectively increased by the addition of the deficient vitamins.

SUMMARY

1. A comparative microbiological assay of the overall potency of the growth-factors of liver extracts, has been carried out using a strain of lactobacillus culture (N.C.T.C.: 2078), as the test organism. Three varieties of sharks, *Carcharinus melanopterus, Galeocerdo tigrinus, Carcharinus limbatus,* whose liver residues constitute a useful bye-product of the shark liver oil industry, have been investigated.

2. *Carcharinus limbatus* has been found to yield the most potent extract with a functional similarity approximating to the standard Lily liver extract.

3. Shark livers with high contents of the fat-soluble vitamins appear to constitute poor sources of the water-soluble B-complex. The two groups of vitamins appear to occur together in the inverse ratio (see Table I).

4. Recent clinical reports suggest that the antianæmic factors (extrinsic) are identifiable with some of the important members of the B-complex. Further, recent studies have shown that the B-vitamins are essential for the synthesis of hæmoglobin and the formation of corpuscles. These observations are significant in relation to the functional behaviour of the Pisori liver extract and suggest that it might prove a good source of the antianæmic factors.

5. The response of the various extracts at their limiting concentrations to the addition of specific vitamin shows that some of the vitamins are lacking in them; the addition should serve to render the extract physiologically more balanced and potent.

Our grateful thanks are due to Sir J. C. Ghosh for his kind interest in these studies.

1. William, R. J., *et al., J. Amer. Chem. Soc.*, 1939, **61**, 454; *Ibid.*, 1939, **60**, 2719. 2. Kuhn, R., and Wieland, T., *Ber.*, 1940, **73B**, 962. 3. Snell, E. E., and Strong, F. M., *Ind. Eng. Chem., Anal. Ed.*, 1939, **11**, 346. 4. Pennington, D., Snell, E. E., and Williams, R. J., *J. Biol. Chem.* 1940, **135**, 213.

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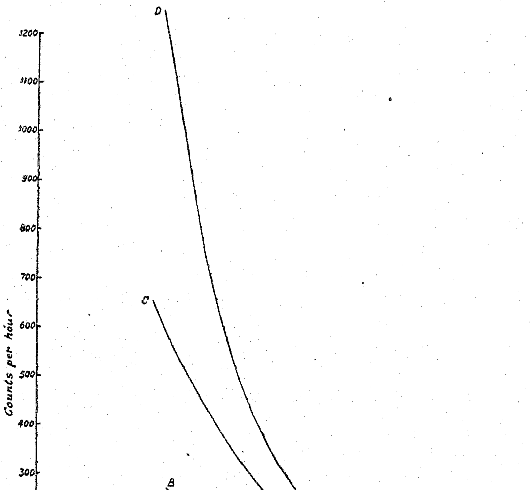
LETTERS TO THE EDITOR

LATITUDE EFFECT FOR MESONS

SCHEIN, Jesse and Wollan,[1,2] and Schein, Jesse and Grötzinger[3] have measured the variation with altitude of the vertical intensity of mesons penetrating 10 cms. of lead at Chicago, magnetic latitude 52·5° N. Similar measurements were made earlier by Dymond[4] at Edinburgh, magnetic latitude 59° N, but the work was interrupted by the war and only a preliminary note has been published. No such measurements have yet been made near the geomagnetic equator. We have, therefore, measured in an airplane the vertical intensity of mesons penetrating a 20 cms. block of lead absorber at Bangalore, magnetic latitude 3·3° N, up to a height corresponding to a pressure of 275 millibars 32,000 ft., with a quadruple coincidence counter telescope in which the extreme counters were 35 cms. apart. The counters were 15 cms. long and 3½ cms. in diameter. The geometry of the telescope was, therefore, such that a particle recorded at the maximum allowed angle of 22° would travel a thickness of the atmosphere and absorber only 8 per cent. greater than a particle arriving vertically.

In the figure we have plotted our results giving the intensity of mesons penetrating 20 cms. of lead at 3·3° N as curve A and, for comparison, the latest results of Schein, Jesse and Wollan[2] for the intensity of mesons at 52·5° N as curve B. The two curves have been fitted at sea-level to allow for the known latitude and longitude effect[5] of 12 per cent. In the same figure we have plotted the variation of the total vertical intensity with altitude at 3·3° N as given by Neher and Pickering[6] for a triple coincidence counter telescope as curve C, this curve being fitted to our curve so as to show a ratio of vertical meson intensity to total vertical intensity of 80 per cent. as observed at ground-level at Bangalore. Curve D gives the variation of the total vertical intensity with altitude as measured by Pfotzer[7] at a magnetic latitude of 49° N. The four curves together show at a glance the striking fact that whereas the latitude effect between 3·3° N and 49° N of the total intensity shows a pronounced increase with altitude, the



Curve A—Vertical meson intensity at 3·3° N (Bhabha, Aiya, Hoteko and Saxena). *Curve B*—Vertical meson intensity at 52·5° N (Schein, Jesse and Wollan 1941). *Curve C*—Vertical total intensity at 3·3° N (Neher and Pickering). *Curve D*—Vertical total intensity at 49° N (Pfotzer).

penetrating component shows practically no such increase of latitude effect even to heights corresponding to a pressure of 275 millibars. Our results give at least qualitative support to the theory of Hamilton, Heitler and Peng[8] according to which the penetrating component

should show only a slightly greater latitude effect than at sea-level up to the heights corresponding to a pressure of 100 millibars. The difference in the geometry of the counter telescopes used by the different authors and the statistical accuracy of the results do not yet permit a quantitative comparison.

A detailed report of this work together with other results will be published shortly elsewhere.

It is with pleasure that we express our gratitude to Col. M. C. Robinson, Commanding Officer of the 84th Air Depot of the U.S.A. Air Force, for giving the permission for the flight, and also to Major G. Denis, Capt. J. Claunch, Lt. Mack, and Sgt. Beaver, under him, for their whole-hearted co-operation.

H. J. Bhabha.
S. V. Chandrashekhar Aiya.
H. E. Hoteko.
R. C. Saxena.
Cosmic Ray Research Unit,
Indian Institute of Science,
Bangalore,
April 10, 1945.

1. Schein, Jesse and Wollan, *Phys. Rev.*, 1940, **57**, 847. 2. —, —, —, *Ibid.*, 1941, **59**, 615. 3. —, — and Grötzinger, *Ibid.*, 1940, **58**, 1027. 4. Dymond, *Nature*, 1939, **144**, 782. 5. Millikan, Neher and Pickering, *Phys. Rev.*, 1942, **61**, 397. 6. Neher and Pickering, *Ibid.*, 1942, **61**, 407. 7. Pfotzer, *Zeits. f. Physik*, 1936, **23**, 102. 8. Hamilton, Heitler and Peng, *Phys. Rev.*, 1943, **64**, 78.

EFFECT OF THE RATE OF TRICKLE ON THE MASS OF THE DROP

In determining the surface tension of a liquid by the drop weight method it is necessary that the drops should be formed sufficiently slowly so that the conditions at the time of separation of each drop from the nozzle of the tube are truly static or very nearly so. The rate of formation of drops in Lord Rayleigh's[1] experiments was about a drop per minute, while Edser[2] and Worsnop and Flint[3] recommend a rate even as high as 60 drops per minute. An interesting point was revealed when actually an experiment was performed to bring out the effect of the rate of trickle on the mass of the drops formed. The results (Fig. 1) show that for small rates of trickle, the mass of the drop increases very slowly, but for larger rates it increases very rapidly to large values when the discrete drops are about to merge into a continuous jet.

A drop separates from the main bulk of the liquid at the nozzle when its weight just exceeds the pull due to Surface Tension. With increasing rate of trickle the liquid rushes out with an acceleration; this effectively reduces the weight of the drop and the drop grows to larger dimensions till the effective weight pulls it down. According to Lord Rayleigh for static conditions (*i.e.*, rate of trickle $n = 0$) $m_0 g = 3{\cdot}8\,r\mathrm{T}$ where m_0 is the weight of the drop when $n = 0$; r is the external radius of the capillary orifice and T is the surface tension of the liquid. If "a" represents the equivalent acceleration of the liquid when the rate of

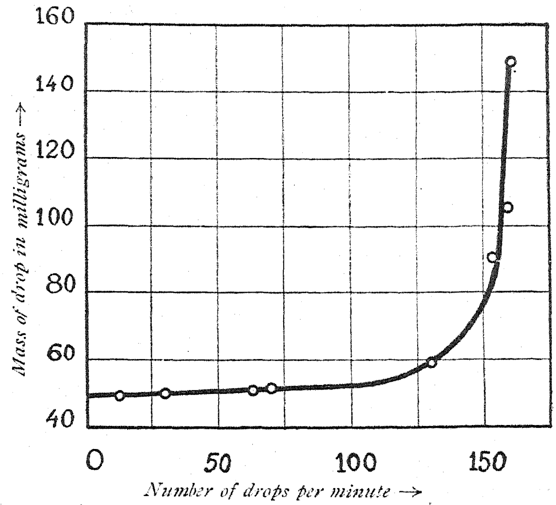


FIG. 1. Variation of the mass of drop with the rate of trickle

trickle is n drops per minute and m is the corresponding mass of the drop, we may write

$$m\,(g - a) = 3{\cdot}8r\mathrm{T} = m_0 g \quad \therefore m\left(1 - \frac{a}{g}\right) = m.$$

Now the acceleration "a" depends on "n" the rate of trickle. Therefore we write $m[1 - f(n)] = m_0$ where $f(n) = 0$, when $n = 0$. Since the experimental curve is nearly a rectangular hyperbola $f(n)$ probably has the form kn^x where k and x are constants.

In order to confirm the above explanation qualitatively experiments were carried out using strong electric fields to aid the acceleration of gravity. The drops actually separate out at an earlier stage of growth than when such an aiding force is absent.

Department of Physics,
Nowrosjee Wadia College,
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January 15, 1945.

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OCCURRENCE OF FLUORSPAR NEAR MALHAN, JUBBALPUR DT., C.P.

This note reports the occurrence of a workable deposit of fluorite near Malhan (N. 80° 31′; E. 23° 40′), in the Jubbalpur District, C.P. The place is about 7 miles S.W. of Rupaund Railway Station on the Katni-Bilaspur branch of B.N.R. The country rock consists of dolomite with intercalations of slate and chlorite schists of Dharwar age. The strike varies from E.-W. to N.W.-S.E. and the dip is northwards varying from 30° to 90°. The dolomite is often found to be intruded by quartz veins which vary in width from 4′ to ½″. There are also basic dyke rocks intruded into the country rock.

Fluorite occurs only in pockets in the dolomite. There are no regular veins or zones which can be traced for some distance. Galena, chalcopyrites, malachite, barytes and calcite are associated. Quartz veins are found quite close to most of the fluorite-bearing pockets. The fluorite of this area is usually pink, but colourless and blue varieties are also present. This colour disappears on heating the mineral. These different varieties of fluorite were tested for fluorescence under ultra-violet light from a mercury vapour lamp. Except one blue variety which showed slight blue fluorescence, the others were non-fluorescent. It was observed, however, that pink fluorite after being decolourized on heating, gives a fairly strong fluorescence when placed in ultra-violet light.

The country close to the lode and the vein materials do not apparently show any sign of shearing in the field but a definite indication of shearing of the minerals has been detected under the microscope. The country rock has been successively replaced by barytes, mica, metalliferous ore-minerals, fluorite and quartz. It is probable that shearing action took place when the ore-minerals were being deposited or before their deposition was complete, that is to say, before the beginning of the fluorite deposition. This is very easily noticed under the microscope, as there is no trace of any shearing phenomena in the fluorite mineral, of the region. The sulphide minerals usually occur as irregular masses scattered at random from the walls to the centre of the pockets. Barytes is a common gangue mineral present in almost all the veins. In some of the fluorite bearing pockets baryte and fluorite form alternating bands and some of the barytes lumps show a coating of fluorite on the surface. Argentiferous galena occurring along the fluorite-bearing pockets is considered as indication of the magmatic origin of the mineralizing materials in this region. Crystallisation of fluorspar is undoubtedly the pneumatolitic phase of the mineralizing magma.

Four prospecting trenches ($30' \times 12' \times 10'$) have been dug in this area. Out of these four, two are producing galena, and fluorite and one of them contains copper-ore also. The third one produces argentiferous galena and copper ores (melachite and traces of primary sulphide). The fourth one yields melachite incrustations along with the other gangue minerals. In all the trenches the trend of deposits are found to run N.N.W.-S.S.E. In the first trench the galena and fluorite-producing zone is about 3', out of which the western portion produces fluorspar only. Fluorite produced from this pit is generally medium-grained and pink in colour. The yield of fluorite is 20 to 25 per cent. of the rock-body that has been excavated. The second trench produces also fluorite, the pit has been dug about 10' away from the first one along the line of the strike of the lode. The quality produced is good and comparatively bigger crystals are found. The fluorite-producing zone is about 1½ to 2' wide. The percentage of fluorite in the rock-body is about 25 to 30 per cent. of the rock excavated. Hand-picking by breaking the lump rock raised the percentage to nearly 50 per cent. and it is expected that crushing and washing would increase the concentration of fluorite upto a minimum commercial specification. A more elaborate milling with figs. and tables followed by a suitable flotation-concentration operation, might further increase the percentage of fluorite to a very high degree. As regards the quantity of material available in this area, it is difficult to say anything definitely at this stage, a further detail prospecting work would prove ore reserve.

Geological Laboratory,
Post-Graduate Science Dept.,
Calcutta University,
January 10, 1945.

S. Deb.
S. K. Roy.

OCCURRENCE OF GARNETIFEROUS LEPTYNITE AT MEENAKSHNIPURAM, COCHIN STATE

Late Mr. K. K. Sen Gupta, in his 1911 report on the Geology of Cochin State, described two garnet-bearing rocks, one along the tramway line between Mudavarichal and Oorukumbankutty and the other at Pothupara. "The rocks of South Travancore are conspicuous by the abundance of garnets present in them, those of North Travancore and Cochin hardly growing any. Sir Thomas Holland discusses the origin and growth of garnets from pyroxenes and their micropegmatite intergrowths in pyroxenic rocks of South India. The total absence of garnetiferous rocks in the State except two exposures, makes it extremely difficult to verify his conclusion."

We have recently found a big quarry of garnetiferous leptynite on the northern side of the road at the western extremity of Meenakshipuram village in Chittur Taluk. This rock exactly resembles the garnetiferous leptynite of South Travancore. It is leucocratic and consists of quartz, felspar and garnet with biotite and magnetite as accessory minerals. The garnet occurs as reddish-brown grains and patches and belongs to the variety, grossularite.

This discovery proves that this rock is not confined to South Travancore. The relations of this rock with the other rocks of the area are being studied.

Ernakulam,
February 7, 1945.

T. Sudhakara Menon.

ASSAY OF THE GROWTH-PROMOTING ACTIVITY OF THE "FATS" ASSOCIATED WITH SOME CEREALS

It has been shown[1,2,3] that the larvæ of the rice moth (*Corcyra cephalonica* Staint) can be employed as a test animal for the biological assay of fat-soluble factors. It was of interest to make a comparative study of the growth-promoting potency of "Fats" from cereals obtained by solvent extraction. Chloroform-extracted jowar constituted the basal diet from which the "whole" diets were reconstituted by enriching the flour with the fat from each of the cereals to the extent of 4·28 per cent.,—this being the percentage of "fat" in jowar.

A further comparison of the fats of the cereals was made with a sample of shark liver oil.

Results are tabulated below:—

TABLE I

Diet	Average weightof 10 larvæ in mgm. after					Survivals
	0 days	8 days	14 days	21 days	Pupation at 21 days	
I	9·08	141·90	352·58	All pupated	All pupated	12 out of 12
II	9·28	16·38	16·82	13·04	No pupæ	4 ,, 12

Diet I—Whole jowar. Diet II—Chloroform extracted jowar.

TABLE II

Diet	Average weight of 10 larvæ in mgm. after					Survivals
	0 days	8 days	14 days	21 days	Pupation at 21 days	
I	4·82	63·76	173·60	290·72	2 larvæ, 10 pupæ	12 out of 14
II	4·84	46·30	151·44	226·46	2 pupæ, 12 larvæ	14 ,, 14
III	4·50	46·86	116·86	181·26	No pupæ	14 ,, 14
IV	4·64	25·88	68·26	122·98	,,	12 ,, 16

Diet I—Chloroform extracted jowar + Wheat fat (4·28%). Diet II—Chloroform extracted jowar + Ragi fat (4·28%). Diet III—Chloroform extracted jowar + Jowar fat (4·28%). Diet IV—Chloroform extracted jowar + Fish oil (4·28%).

TABLE III

Diet	Average weight of 10 larvæ in mgm. after					Survivals
	0 days	13 days	19 days	26 days	Pupation at 26 days	
I (*a*)	3·54	62·92	..	All pupated	All pupated	16 out of 16
(*b*)	5·82	165·92	386·46	,,	,,	16 ,, 16
II (*a*)	3·88	64·60	146·08	241·02	2 pupæ, 14 larvæ	16 ,, 16
(*b*)	5·90	91·34	175·02	270·62	8 larvæ, 6 pupæ	14 ,, 16
III (*a*)	3·98	53·68	121·46	..	2 pupæ, 12 larvæ	14 ,, 16
(*b*)	7·16	91·52	156·88	..	...	..
IV (*a*)	4·14	47·52	114·56	233·82	2 pupæ, 10 larvæ	12 ,, 16
(*b*)	6·02	91·74	150·12	156·50	8 pupæ, 4 larvæ	12 ,, 16
V (*a*)	4·24	35·12	56·58	100·02	No pupæ	14 ,, 16
(*b*)	6·06	46·32	78·72	134·66	,,	16 ,, 16

Diet I—Whole jowar. Diet II—Chloroform extracted jowar + Wheat fat (4·28%). Diet III—Chloroform extracted jowar + Ragi fat (4·28%). Diet IV—Chloroform extracted jowar + Jowar fat (4·28%). Diet V—Chloroform extracted jowar + Fish oil (4·28%).

TABLE IV

Diet	Average weight of 10 larvæ in mgm. after			Survivals
	0 days	7 days	14 days	
I	6·48	44·66	196·90	16 out of 16
II (*a*)	7·04	45·12	164·52	16 ,, 16
(*b*)	8·37	60·42	192·98	11 ,, 12
III (*a*)	6·84	41·76	156·16	14 ,, 16
(*b*)	8·25	58·69	179·46	11 ,, 12

Diet I—Whole jowar, Diet II—Chloroform extracted jowar + Ragi fat (4·28%). Diet III—Chloroform extracted jowar + Jowar fat (4·28%).

Results given in Table I show that the chloroform-extracted jowar, constituted a reasonably good basal diet for the studies in question; extraction with the chloroform deprives the cereal practically completely of its fat-soluble growth-promoting factors. It will be observed (see Table I) that the reconstituted diet (chloroform-extracted jowar with an equivalent quantity of the chloroform extract) does not restore completely the full potency inherent to the whole jowar. This is possibly due to the fact that during the process of solvent etraction, the essential factors are partially destroyed or inactivated by heat or oxidation.

A study of results given in Tables II, III and IV reveals:—(1) Of the "Fats" investigated, the one from wheat exhibits the highest potency, not only from the point of view of the rapidity of growth but also from the standpoint of the percentages of the survivals and the pupations. (2) Ragi "fat" shows a slightly higher potency than jowar "fat". (3) Ramaswamy *et al.*[4] observed that ragi does not support the growth of the larvæ as well as jowar; they attribute this fact to the lower "fat" content of ragi. But our experiments show that the "quality" of the "ragi fat" is slightly higher than that from jowar. (4) The fish oil exhibits the lowest potency.

The experiments show that the larvæ can be conveniently employed for the assay of the potency of "fats"; it is proposed to extend this method for the biological assay of the growth-promoting potency of the "fat" from several strains of yeasts.

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Indian Institute of Science,
Bangalore,
February 14, 1945.

1. Sarma, P. S., and Sreenivasaya, M., *Curr. Sci.*, **1939, 8, 551.** **2.** —, —, *Ibid.*, **1941**, **10**, **525.** **3.** De Souza, V., and Sreenivasaya, M., *Ibid.*, **1944**, **13**, 250. **4.** Ramaswamy, S., *et al.*, *Ibid.*, **1942**, **11**, **53.**

A SIMPLE MICRO-MACERATOR FOR PLANT ANALYSIS

SPECIAL importance is attached by the plant analyst to the primary operation of grinning the experimental material and bring ing it into a condition which facilitates the quantitative extraction of the constituent to be estimated. The available methods of treatment[4,3,1] are unsuitable either because the technique is tedious or because it involves the use of expensive or fragile equipment. An inexpensive, efficient and elegant micro-macerator has been developed, and comparison with the earlier methods and repeated tests with different types of plant tissues have established its suitability and efficiency.

The essential features of the apparatus are illustrated in Fig. 1. The lower portion is made from a thick-walled pyrex tube. The upper end of the tube is blown out in the shape of a thistle funnel with a spout. The lower end of the stopper is ground into the slightly tapered (shaded) portion of the tube by using emery powder and water.

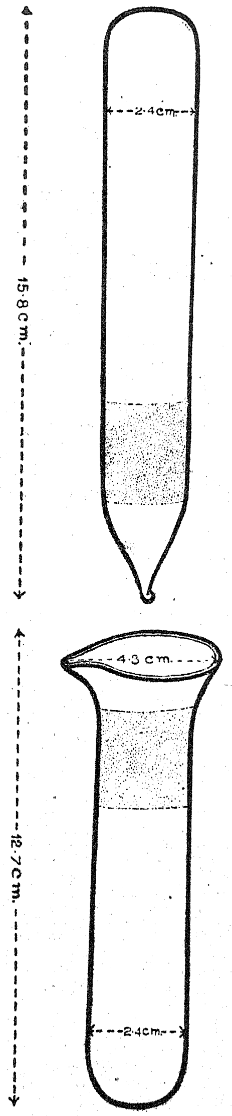

FIG. 1

Procedure.—0·1–0·2 gm. of plant material is weighed out accurately into a tube, moistened with 2-3 ml. of the extractant poured in driblets into the cup of the macerator formed by fixing the stopper to the tube, and ground down to a paste which will gradually creep down the joint into the tube. The pasty mass is transferred to the flask of a micro-extraction apparatus and the tube, the cup and the stopper of the macerator are rinsed 3 or 4 times with fresh quantities of the extractant to facilitate the transfer of all the material to the extraction apparatus. Often it is necessary to rub the last traces of the material with the

pointed end of the stopper. About 10-15 minutes are required to crush 0·1-0·2 gm. of plant material. The material is now ready for the next operation.

Micro-Estimation of Starch.—The plant material used in the experiments was previously extracted with 80 per cent. alcohol, dried at 100° C., and then powdered to pass through a 100-mesh sieve. Duplicate aliquots of the material were weighed out for extraction by the present method. For comparing, the estimation was carried out by the earlier method of the author.[1] The macerated samples were extracted on a boiling water-bath with about 7-10 ml. of 0·7 per cent. KOH solution for 30 minutes with occasional stirring with a glass rod. The mixture was then centrifuged for 5 minutes (2,000 r.p.m.) and the extract transferred to a clean tube. A fresh quantity of the reagent (5 ml.) was added to the plant material and again extracted for 10 minutes. After centrifuging, a test portion of the second extract was tested for starch. In the majority of cases the first extraction removed all the starch from the plant material. Second extraction was necessary only in some cases where the concentration of starch was very high. The starch extract was concentrated, filtered, filter-paper washed 2 or 3 times with distilled water and finally made to volume (25 ml.). Aliquots of the solution were taken for the estimation of starch by the micro-iodine method.[2] Results are presented in Table I.

The results clearly show that the time taken for the complete removal of starch by the present method is considerably less than that required by the earlier technique.

The micro-photographs presented in Figs. 2 and 3 clearly demonstrate the efficiency of the micro-macerator. Fig. 2 shows an iodine-stained ground (100-mesh) stem tissue, and Fig. 3 the same material after passing through the micro-macerator and staining with iodine.

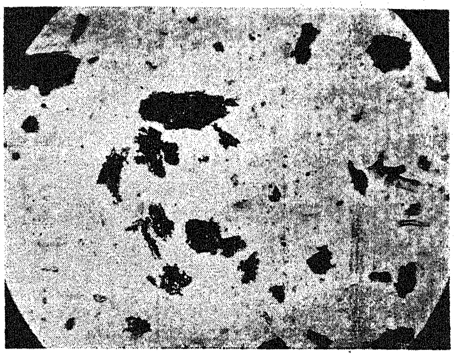

FIG. 2. A sample of stem passed through 100-mesh sieve

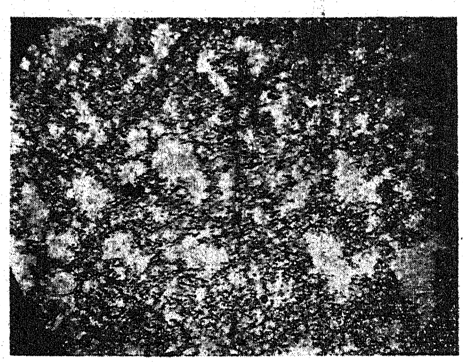

FIG. 3. The same sample of stem (Fig. 2) ground in the micro-macerator

TABLE I

Comparison of methods for starch extraction

Plant material	Sand-tituration method (1938)				Present method			
	Sample analysed (g.)	No. of extractions	Time of extraction (minute)	Starch Per cent. dry wt.	Sample analysed (g.)	No. of extractions	Time of extraction (minute)	Starch Per cent. dry weight
Leaf — S. 1	0·1180	4	120	5·19	0·1030	1	45	5·03
Leaf — S. 1	0·2857	5	140	4·95	0·2240	1	45	5·22
Leaf — S. 2	0·2011	5	140	6·17	0·1980	1	45	6·04
Leaf — S. 2	0·2430	5	140	5·78	0·3841	2	60	6·04
Stem — S. 3	0·1270	4	120	9·28	0·1352	1	45	9·61
Stem — S. 3	0·2812	5	140	8·62	0·3100	1	45	8·93
Stem — S. 4	0·1740	5	140	6·89	0·1811	1	45	6·49
Stem — S. 4	0·2241	5	140	6·31	0·3450	2	60	6·76

Imperial Agric. Res. Institute,
New Delhi,
January 23, 1945.
J. J. CHINOY.

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MODE OF OCCURRENCE OF VITAMIN A IN SHARK LIVERS

WALD,[1,2] and Hecht, Chase, Shaler and Haig[3], have shown that vitamin A occurs in combination with protein in visual purple of the eye and plays an important rôle in the photochemical reactions accompanying the visual process. Lovern, Edisbury and Morton[4] have shown that on the extraction of oil from livers by non-polar solvents—to avoid denaturation of proteins—vitamin A may still be present partly in combination with protein and partly in oil solution. Working on the distribution of vitamins A_1 and A_2 in different coats of the intestinal tube, Lovern and Morton[5] concluded that the vitamin-protein complex may influence the transport of fatty acids from the intestines. Indirect evidence that vitamin A may partly occur as an integral part of liver tissue, has been observed during a comparative study of the processes of extraction of oil from shark livers. Shark liver containing 60 per cent. or more of oil was found to yield to the pressure exerted by its own weight a considerable quantity of oil on its keeping for a very short time after the removal of the liver from the shark. Two such individual samples of whole livers were selected for the experiments. The oil which oozed out was skimmed off and the liver treated with high pressure steam in specially fabricated steaming vats to extract the rest of the oil. The vitamin A potencies and a few chemical and physical characteristics of these fractions were then determined and compared. Vitamin A potency was assayed on the whole oil by the Carr-Price reaction using a B.D.H. pattern Lovibond Tintometer. The oil data were obtained by methods described before.[6]

Comparative data are presented in the table given below:—

TABLE I

Comparison of the two oils

Particulars	Sample I		Sample II	
Weight of liver	87 lbs.		82 lbs.	
Total weight of oil	62 lbs.		60 lbs.	
Percentage yield	71·3		74·5	
Sample of oil	Oozed out	Steam extracted	Oozed out	Steam extracted
Vitamin A potency Carr-Price Value	33·2	84·9	c. 1·0	16·9
Colour	Yellow	Orange	Yellow	Orange
Refractive Index, 35° C.	1·4623	1·4635	1·4653	1·4659
Acid Value, mgm. KOH/gm.	0·45	1·1	0·5	2·6
Saponification Value	154·4	155·6	168·6	172·0
Iodine Value: Wijs	78·54	83·71	102·3	100·2

The table shows that vitamin A does not occur wholly in oil solution in shark livers; It appears to be partly present as a complex with protein. This has some bearing on the conditions to be adopted during any oil extraction process.

Thanks are due to the Director of Industries and Commerce, Madras, for permission to publish this note.

Technical Research Lab.,
Govt. Oil Factory,
Calicut, ULLAL SUNDAR KINI.
January 12, 1945.

1. Wald, *J. Gen. Physiol.*, **1935**, **18**, 905. 2. —, *Ibid.*, **1938**, **19**, **35**. 3. Hecht, Chase, Shaler and Haig, *Science*, **1936**, **84**, **331**. 4. Lovern, Edisbury, and Morton, *Nature* (London), **1937**, **140**, 276. 5. Lovern and Morton, *Biochem. J.*, **1939**, **33**, **330**. 6. Kini, U.S., *J. Ind. Chem. Soc., Indr. and News Edn.*, **1944**, **7**, 1, 32.

PYRETHRUM IN KASHMIR

PYRETHRUM has received considerable attention in India during recent years. Among the Provinces and Indian States who have taken up its cultivation, Kashmir leads with nearly 1,500 acres of land under Pyrethrum. A comparative study has been made of the pyrethrin content of the flower-heads collected from plantations situated at different altitudes during the past two years, to establish the optimum conditions for its collection, cultivation and drying under the local conditions. A large number of samples were collected from each individual plantation at different stages of blossoming of the flower-heads and assayed in this laboratory.

Results (Table I) indicate that the pyrethrin content tends to increase from the closed to the opened stage, but when the flowers are fully opened this percentage shows a decrease. This is obviously caused by the increase in the weight of the flower-heads which follows pollination and the subsequent formation of seed. This latter growth results in an increase of nearly 60 per cent. in the weight of flower-heads. Table I below details the results summarised above.

TABLE I

S. No.	Locality	Altitude (feet above sea-level)	Average weight of individual flower	Sate of Maturity	Total Pyrethrins per cent.
			Grams		
1	I	5000	0·086	Unopened	0·57
2	I	5000	0·108	Half opened	0·8
3		5000	0·161	Opened	0·9
4		5000	0·263	Fully opened	0·78
5	II	5500	0·094	Unopened	0·82
6		5500	0·108	Half opened	0·83
7		5500	0·180	Opened	0·92
8		5500	0·294	Fully opened	0·71
9	III	5500	0·086	Half opened	0·76
10		5500	0·125	Half opened	0·79
11		5500	0·195	Opened	0·91
12		5500	0·217	Fully opened	0·79

Altitude.—Table II indicates that whereas pyrehrins can profitably be cultivated at altitudes of 5,000 ft. to 8,000 ft. above sea-level, an altitude of 6,000 ft. represents the optimum height for the cultivation of this plant in Kashmir.

TABLE II

S. No.	1	2	3	4	5
Locality	I	II	III	IV	V
Altitudes feet above sea-level	5000	5500	6000	7000	8000
Total Pyrethrins of sun-dried samples per cent.	0·95	1·02	1·1	1·01	1·0

An interesting point is revealed in Table III with respect to the mode of drying. Sun-dried flower-heads show a higher pyrethrin percentage than those dried in the shade. This is due to the humid weather in Kashmir during the harvesting period when the flower-heads remain in contact with moisture for too long in shade and cause decomposition of the pyrethrins.

TABLE III

S. No.	1	2	3	4	5
Locality	I	II	III	IV	V
Pyrethrin contents of flowers dried under sun : per cent.	1·02	0·98	0·95	1·01	0·96
Pyrethrin contents of flowers dried in shade: per cent.	0·87	0·92	0·89	0·91	0·90

It has, however, been found that flower-heads dried partly in the sun for three days and subsequently in shade contain a higher percentage of the active principles. A detailed investigation of this is in hand.

AGE OF THE PLANTATION

An examination of the flower-heads in respect to the age of the plantation reveals (Table IV) a gradual fall in the active-principle content from year to year. This is probably due to the exhaustion of soil and investigation in connection with the soil conditions and manuring is progressing.

TABLE IV

Locality	I	II	III
Altitude (in feet above sea-level)	5000	5000	5500
Plantation age at the time of harvesting : years	4	3	2
Total pyrethrins or sun-dried samples : per cent.	0·95	0·96	1·02

Locality	Krewa Feth Garh	Brimel Lewar
Pyrethrin content : 1943 crop per cent.	0·9	0·92
Pyrethrin content : 1944 crop. per cent.	0·75	0·85

All the assays described above have been conducted by the method of Tattersfield and Hobson (*Drugs and Calenicals*, by Garratt, p. 259).

I. C. CHOPRA.
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K. L. HANDA.
M. HABIBULLAH.
P. ASSA NAND.

Drug Research Laboratory,
Jammu Tawi (Kashmir),
February 9, 1945.

THE OCCURRENCE OF A PSEUDO-BRANCH IN THE FAMILY *OPHICEPHALIDAE* (TELEOSTOMI)

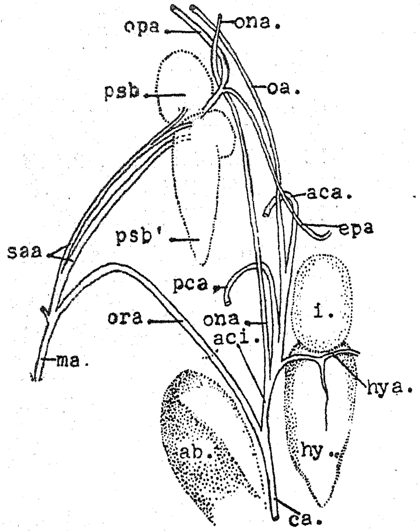
DURING the course of the study of the embryology of the food-fishes of Mysore, it was noticed that the head sections of the fry of *Ophicephalus gachua* (Ham.) disclosed the presence of a pseudobranch,—a structure which Day[1] described to be absent in the family Ophicephalidæ. In order to decide that it was not a larval feature, adults of *Ophicephalus* and *Channa* were dissected, where also a pseudobranch is now noticed to be present and, therefore, its disposition and vascular supply were studied. Further, it is proposed to describe in this note the arterial vessels of the head in *Ophicephalus* and *Channa*, since no account of the same is available for the former which is studied as a type of bony fishes in our colleges.

In the *Ophicephalus* fry (24 mm.), the pseudobranch is situated anterior to the branchial cavity and in a ventral dissection, it is noticed to be covered over partially by the adductor muscle extending between the pterygoquadrate and the parasphenoid. The orbital artery arising from the lateral dorsal aorta gives a branch to the pseudobranch which is its source of blood supply; the efferent pseudobranchial artery arises from the anterior end of it and goes off to the eye as the ophthalmica magna artery. A connection between the efferent pseudobranchial artery and ophthalmica magna artery with the arteria carotis interna is not noticed.

Adults of *Ophicephalus striatus* Bloch., *O. punctatus* Bloch., and *Channa orientalis* Bl. Schn., were examined. The pseudobranch situated far anteriorly to the branchial cavity is completely covered over by the adductor muscle. When the muscle is taken away, the pseudobranch, pink in colour, is seen in two parts: an oval anterior (Text-Fig. psb.) and a longish conical posterior with a medial protuberance (*psb'*.).

The vascular connexions of the pseudobranch in the adult *Ophicephalus* are different from those of the fry. In the adult, the carotid artery (ca.) arising from the united third and fourth efferent branchial arteries proceeds anteromedially to the auditory bulla (ab.) dorsally to the parasphenoid. It gives off a large orbital artery (ora.) (erroneously referred to as external carotid) and runs intracranially passing dorsally to the parasphenoid as before. The anteria carotis interna (aci.) now gives off a large orbitonasal artery (ona.) which passing dorsally to the parasphenoid emerges laterally near the pseudobranch and runs in the roof of the mouth to nasal region; a hypophysial

artery (hya.) which uniting with its companion gives off a small artery posteriorly; a slender optic artery (oa.) proceeding on the ventral



Drawing of the pseudobranch and associated arteries of *Ophicephalus striatus* Bloch. (ventral dissection, enlarged).

aspect of the optic nerve to the eye; a large posterior cerebral artery (pca.) vascularising the saccus vasculosus region and an anterior cerebral artery (aca.) proceeding to the fore-brain region. The orbital artery runs in a canal in the prootic and emerges from the anterior trigeminofacialis orifice. It runs anteriorly to the medial hyomandibular projection on the mesial aspect of the bone and divides into two principal branches; one goes off as the mandibular artery (ma.) while the other proceeds anteriorly and enters the pseudobranch as in *Channa* or divides into two before opening into the same as in *Ophicephalus* (saa.). This vessel from the orbital artery is a secondary connexion supplying arterial blood to the pseudobranch. From the pseudobranch, there arises the efferent pseudobranchial artery (epa.) which after giving off a large ophthalmica magna artery (opa.) proceeding to the eye, runs posteriorly as a slender vessel and anatomoses with its fellow from the opposite side in front of the hypophysis (i., hy.).

While the description given above holds good for a number of dissections, two important variations have been noticed. In one specimen, one of the afferent branches to the pseudobranch, instead of terminating in the organ runs further as the orbitonasal artery and in the same specimen, the orbitonasal artery arising from the arteria carotis interna is, however, absent; in another specimen, in addition to the secondary afferent artery a small branch from the orbitonasal artery also supplies the pseudobranch before the latter runs to the nasal region.

I wish to express my sincere thanks to Prof. A. Subba Rau for help and to Mr. P. E. P. Deraniyagala, Director of Museums, Pelmadulla, Ceylon, for specimens of *Channa*.

Department of Zoology,
Intermediate College, L. S. Ramaswami.
Mysore,
November 20, 1944.

1. Day, F., *Fauna of British India: Fishes*, 1889, **2**, 359. 2. Goodrich, E. S., *Structure and Development of Vertebrates, London*, 1937.

INTERESTING MODE OF THE LIFE-CYCLE OF THE LUNG WORM, *VARESTRONGYLUS PNEUMONICUS* BHALERAO, 1932

The lung worm, *Varestrongylus pneumonicus*, was discovered by the writer in 1932 from the bronchi of the goat, *Capra sibiricus*, and the sheep, *Ovis hodgsoni* and *O. nahura*, at Mukteswar. It has since been recorded from goats and sheep in the hills of Bengal, Punjab and the N.W. Frontier Province. This worm affects a large percentage of goats and causes heavy mortality. Because of the great economic importance of this parasite it was decided to study its life-cycle. At the outset, attempts were made to ascertain if it had a direct life-cycle like most of the strongyles. The first-stage larvæ, hatched from the eggs, were kept in culture at varying temperatures, to see if they underwent any change of structure and attained the infective stage. The larvæ lived in culture for eighty days, but no change of structure was noticed except a reduction of granules in the cells of the intestinal wall. Two conclusions could be drawn from these observations. The first and most improbable one being that the first-stage larvæ themselves might infect the definitive hosts, and the second that some intermediate host might be intercalated in the life-cycle of the parasite. In order to verify the former hypothesis the first-stage larvæ were fed to kids, confined to stalls and fed on tree-leaves. Autopsy of these animals after three months revealed that they had not been infected. Attempts were then made to see if the larvæ underwent some change on coming in contact with the commonest land molluscs at Mukteswar. The molluscs tried were *Macrochlamys* (*Euaustenia*) *cassida* and *Girasia* sp. The latter could not be infected, but the former picked up the infection readily. Within 24 hours after contact with these snails, the first-stage larvæ were transformed into the second-stage and these later became infective larvæ. The infective larvæ were localised on the foot and the mantle of the snails. The infected snails died within three weeks of the infection, but it was observed that the infective larvæ continued to live for more than a week after the death of the snails. Large number of larvæ recovered from the dead snails were drenched to some kids which, as before, were confined to a stall and fed on tree-leaves. The control animals were kept by the side of infected ones and were similarly fed. Ten weeks after the infection, the infected as well as the control animals, were slaughtered. Examination

of lungs revealed the presence of *V. pneumonicus* in the infected animals only, the controls being completely free. It has thus been proved that the lung worm, *V. pneumonicus* utilises the land snail, *Macrochlamys* (*Euaustenia*) *cassida*, as an intermediate host for completion of its life-cycle.

Veterinary Zoology Section,
Imperial Veterinary Research
Institute, Izatnagar, G. D. BHALERAO.
January 22, 1945.

ON THE PATHOGENICITY OF *SETARIA CERVI* (RUD. 1819) IN BUFFALOES

THE worm is generally considered non-pathogenic; but there are a few records of its accidental pathogenicity in literature. Purvis[2] states to have seen the worm associated with pathological lesions on four occasions: (1) with a patch of hæmorrhagic inflammation on the visceral peritoneum, about five inches in diameter; this coincided with the presence of some six to eight worms; (2 & 3) with fibrinous peritoneal exudate; and (4) with calcified material of similar appearance. Poisson and Buck[1] point out that while *S. cervi* usually occurs in very large numbers in the peritoneum and appears not to have any pathological effect, it may occur in other organs such as lymphatic tissues, spleen and right heart, where the parasite may be pathological.

The author's material consists of small intestine with a parasite embedded in each; these having been regularly collected from twenty of the one year-old buffalo calves. On the average, six such pieces per animal could be collected.

The material can be grouped into:—

(1) The parasite lying between the muscular and serous membranes.

(2) The parasite being coiled at one end, the other half being straight under the visceral peritoneum.

(3) The parasite with about anterior one-fourth out in the peritoneal cavity and the rest coiled in a loop under the serosa, the parasite being probably in a state of emergence.

(4) The parasite lying in a degenerated condition in the same site as mentioned for the above three categories.

In all these pieces in the living state, the parasites were throughout surrounded by a reddish zone. The pieces were fixed in Buion fluid and then transferred to 50 per cent. alcohol after 24 hours. After keeping them in 50 per cent. alcohol for seven days, serosa from one half of a piece was stripped off with the parasite embedded in it and was cleared in creosote. The other half of the piece was used for section cutting. The part cleared with creosote presented the anterior part of the parasite in its full form. This was surrounded by a stained zone of cells corresponding to the 'red zone' seen with the naked eye. Fibrous tissue which had remained unstained surrounded the stained zone. In the microphotograph the parasite is surrounded by endothelial cells and there is slight congestion. The section on the whole gives an appearance of a nodule.

Transverse Section of Serosa with *S. cervi* embedded in it × 450

The regular appearance of the parasites in the sites mentioned and the fact that they set up a reaction in these sites, shows that the parasite is definitely pathogenic. The peculiarity of their disposition, *i.e.*, lying spirally under the serosa, in a state of emergence and a degenerate appearance with the half of the parasite coiled at one end and the other half straight as though not having been successful in emerging, shows that the parasites pass sometime in these tissues before final emergence.

Military Dehydrated
Meat Factory, Agra, M. M. SARWAR.
February 6, 1945.

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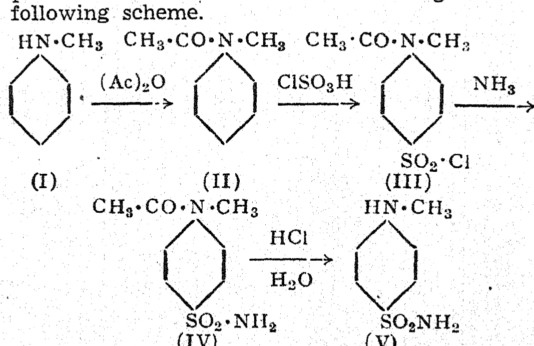
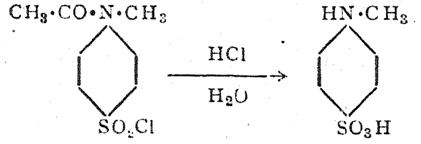
1. Poisson, H., and Buck, G., *Bull. de la. Soci. de Pathologia Exotique*, **1936**, **29**, **933–34**. 2. Purvis, G. B., *The Veterinary Record*, May 9th, 1931.

A NEW SULPHONAMIDE

ON referring to literature neither 4-N-methyl-amino benzene sulphonamide nor its intermediates were described. Therefore the total synthesis of 4-N-methyl-amino benzene sulphonamide was undertaken according to the following scheme.





(III) (VI)

N-methyl-acetanilide (*II*).—20 Gms. methylaniline (I) (b.p. 192° C.) was reacted with equal weight of acetic anhydride. Much heat was generated. On cooling, the mixture was poured into an equal volume of water. Methylacetanilide did not crystallise even on keeping in the refrigerator for several days. The aqueous layer was decanted and a few c.c. of strong ammonia were put in it, when the whole crystallized in a mass. On recrystallization from benzene, it melted at 100° C. (yield theoretical).

4-*N-methyl-acetamino benzene sulphon chloride* (III).—The procedure for this preparation is a slight modification of the usual method. In a 200 c.c. beaker was placed 117 gms. (10 mols.) of chlorosulphonic acid. This was cooled to $-5°$ C. and 14·9 gms. (1 mol.) of (II) was added in one hour. The temperature was maintained below 5° C. during the addition. The mixture was then heated for two hours at 60° C. and poured on a large quantity of crushed ice. Sulphon chloride precipitated in a yellowish mass, which settled down quickly. The acid water was decanted—the precipitate was taken up in chloroform, the solution was dried with anhydrous calcium chloride. On the removal of chloroform 24 gms. of the product were obtained (yield 50 per cent.). After several recrystallizations from benzene pure sample of (III) was obtained (m.p. 126° C.).

4-*N-methyl-acetamino benzene sulphonamide* (*IV*).—To 4·8 gms. of (III) contained in 50 c.c. Erlenmeyer flask, was added 50 c.c. of concentrated ammonia. The mixture was heated on a water-bath until a volume of 10 c.c. remained and then made neutral with dilute acetic acid. A precipitate of (IV) was obtained weighing 4 gms. (90 per cent. yield). Several crystallizations from 66 per cent. alcohol gave a sample of (IV) (m.p. 155° C.).

4-*N-methyl-amino benzene sulphonamide* (*V*).—To a solution of 2·5 gms. of (IV) in 25 c.c., absolute ethyl alcohol and 20 c.c. of concentrated hydrochloric acid was added. The resulting solution was heated for 30 minutes until a volume of 10 c.c. remained. Addition of water gave a clear solution showing complete deacetylation. It was made ammonical and a precipitate weighing 2·1 gms. (yield 85 per cent.). Successive crystallization from dilute alcohol gave a purified sample (m.p. 166° C.).

4-*N-methyl-amino benzene sulphonic acid* (*VI*).—To 2 gms. of (III) in 100 c.c. Erlenmeyer flask, was added a solution of 25 c.c. hydrochloric acid and 25 c.c. water. A clear yellow solution resulted after refluxing for a few minutes. After a further heating of 20 minutes and cooling no crystals of insoluble hydrochloride separated. On further evaporation of the solution and cooling to 0° crystals were obtained, which on recrystallization from alcohol were obtained in a purified form and decomposed at 244° C.

SUMMARY

1. 4-N-methyl-amino benzene sulphonamide has been prepared according to the general procedure with some modifications.

2. The action of chlorosulphonic acid on methylacetanilide gave substitution in 4- position in accordance with general rule, which was confirmed by its sulphonic acid.

3. All the compounds (II), (III), (IV) and (V) are very soluble in all solvents and much caution is to be exercised in crystallizing them.

4. Contrary to expectation amide (V) was found to be a lower melting compound than (IV) which has a higher molecular weight.

Hyderabad (Dn.), HABIB HASSAN.
February 5, 1945. LAL MOHAN SRIVASTAVA.

AGRICULTURAL RESEARCH IN U.S.S.R.

ACCORDING to current information, scientific workers at the Leningrad Institute for Plant Culture who were evacuated early in the war have now returned, and the restoration of the greenhouses, laboratories, and other equipment destroyed, is under way. The experimental station is situated three miles from Pavlovsk, near Leningrad, and had given major attention to the development of improved varieties of fruits. While many of the collections were removed to Germany and the remainder neglected, seeds sent to other parts of the Soviet Union have been found to give normal results. It was expected that the autumn of 1944 and the spring of 1945 would provide farm nurseries with 100,000 strawberry cuttings, 50,000 fruit trees, 60,000 currant bushes, and many other plants while, by next summer about 3,000,000 seedlings and cuttings from fruit trees and bushes will be ready. Extensive plans for scientific research are also being made.

Reorganization and expansion are also going on at the Moscow Botanic Gardens, where it is planned to enlarge the area from 250 to 750 acres. The work is organized under sections of plant evolution, experimental ecology, cultivated plants, dendrology, horticulture and floriculture.

The Academy of Sciences has established an experiment station in Northern Siberia, known as the Mountain Targa Station. Located in the Nkrivio Kliuch Valley near the city of Voroshilovussurisky, breeding and selection programs are under way looking toward the development of better crops for cold, short-season regions, the production of hardy fruit trees and bushes, and the adaptation of local wild species to food and medicinal purposes. New methods developed at the station are said to have brought about a potato production of about 12 tons per acre in large-scale fields.

—*Experimental Station Record*, 92, 160 (1945).

REVIEWS

A Treatise on Applied Hydraulics. By Herbert Addison. (Messrs. Chapman & Hall, Ltd., London), 1944. Pp. viii + 614. Price 32/-.

In this third edition of Prof. Addison's treatise on Applied Hydraulics, he has expanded and revised the excellent second edition. The Preface to the first edition is worth quoting, as it explains the author's purpose:

"The purpose of this book is to present a compact summary of the fundamental principles of hydraulics and of the manner in which they are applied by the engineer. Readers who have particularly been kept in mind are those whose work is not directly connected with hydraulics but who require to be kept in touch with the main outlines of hydraulic practice. .... For their benefit the book is divided into two parts, so that when used as a work of reference only the second part dealing with practical applications need as a rule be consulted."

The enormous amount of information contained in less than six hundred pages has only been rendered possible by say, careful condensation and exclusion of what is unessential: yet the treatment is always adequate for the purpose in view and the enlarged Bibliography is helpful. Here, however, all references to recent advances in India is omitted. Purely a serious oversight. There is no reference to the Gibb module, the crump adjustable proportional module (semi-module) nor to the various excellent papers written in India on this subject: while the only reference to Sacey is in the Bibliography (item 72) under the heading "The Sacey Theory of Non-Stability".

It is to be hoped that Prof. Addison will look up the Central Board of Irrigation Publications before his next edition is released. To us in India, the omission is less important: but references to recent Indian advances would be of great help to workers in other countries, including Egypt. The explanatory notes in small type are most helpful, especially those in the chapter on "Flow through Closed Conduits," which give the clearest exposition of frictional loss in closed conduits which I have yet seen. This should be read and re-read by all irrigation engineers.

The references to earlier and later paragraphs are admirable and make it easy to true the full argument from basic theory to its final application without having to read anything which is not general to the particular problem.

The book is well balalanced and clearly produced and well up to the excellent standard we have come to expect from the House of Chapman & Hall.

This is a valuable book of reference.

C. C. INGLIS.

Exercises in Human Physiology. By Sir Thomas Lewis. (Messrs. Macmillan & Co., Ltd., London), 1945. Pp. xiv + 103. Price 3/6.

When a medical student enters the clinical studies from the preclinical, he experiences a discontinuity in the transitional period. He feels that he has to shed some of the past, and is apt to ponder over the usefulness of his preclinical studies then and after. Sir Thomas Lewis' little book smoothens out his difficulties and provides an admirable preparatory to clinical work. This little book will show him that the application of his previous knowledge of Physiology to his immediate clinical problems makes him more fit to deal with the latter; he could apply the previous laboratory methods which he has learned, to human material which he encounters in the hospital with success. The book gives a concise and lucid account of the practical problems of Human Physiology and its size would enable it to be included in the regular curriculum and would not add any heavy burden to the students' lot; on the contrary, it will arouse interest, as he himself would take the place of the laboratory animals. Instead of passing from studies on animals to those on abnormal humans directly, this book provides an intermediate stage of studies on the normal human beings, thus bridging the gulf between the preclinic and clinical eras in medical studies.

The Gondwana and the Gonds. By Inderjit Singh. (The Universal Publishers, Ltd., The Mall, Lucknow), 1944. Pp. 201. Price Rs. 12.

Primitive economics is a somewhat neglected subject everywhere, particularly so in India, where there is not yet a sufficient number of anthropologists to deal with questions connected with the vast tribal population. Dr. Inderjit Singh, in the volume before us, has tried to give us a picture of the economic life of the Gonds. Within the short space at his disposal, it has not been possible for him to go into illustrative details, but he has broken new ground in marshalling the various forces, natural, religious, historical and cultural, in the make up of the economic Gond. Having served a long apprenticeship in anthropological theory and field work under his able teachers in the Lucknow University, Dr. Singh, with the knowledge he possesses of tribal dialects, creates an impression of high objectivity in whatever he has written. This is as it ought to be. It is not possible in this short review to summarise his theme, but readers will find the chapters on "Tribal Settlement and Social Stratification", on the *Gotul* or youth-house, on "Economic Leadership", and the final chapter on "Cultural Contacts and Acculturation" particularly interesting.

Tribal India seems to present almost the same pattern of problems everywhere—ruthless exploitation, total neglect, or half-hearted measures of relief, by those charged with the duty of safeguarding their interests. Dr. Singh argues passionately for a more sympathetic and scientific treatment of tribal problems in Gondwana, for a craft-based system of education and for the conservation of the several traits of value in Gond culture.

A. AIYAPPAN.

Vijnana mattu Sahitya. By K. S. Savanur. (The Students' Own Book Depot, Dharwar), 1944. Pp. vi + 71. Price 12 annas.

This is a reissue in book form of ten articles in Kannada originally published in the *Samyukta Karnataka* Daily. The main theme is the place of Science in the modern world. It has become fashionable in many quarters to blame science for all the ills of the world and the author sets out to show how the fault is not of science but of those who misuse it, and he shows also how Art and Literature can be equally misused. The opinions of men like Generalissimo Chiang Kai-Shek, Sir Richard Gregory and Bertrand Russell have been quoted and commented upon. The author comes to the conclusion that the remedy for the ills caused by the misuse of science is to be found only in a still more extensive application of the method of science to all the fields of human activity. The connection between the various articles is not logically quite complete but the general theme is kept in view. The language is simple and vigorous, and, but for a few peculiarities not familiar to us in Mysore, easily intelligible. It would be such a good thing if the powers that be can be made to realise the truths set out in the book. As a first step, however, we hope that our voting public and its representatives will spend some time in perusing the book and convincing themselves of the truth of the view therein set forth.

T. S. S.

A Life of Travels. By C. S. Rafinesque. *Chronica Botanica*, Vol. 8, No. 2. (The Chronica Botanica Co., Waltham, Mass., U.S.A.; Macmillan and Co., Ltd., Calcutta), 1944. $2.50.

To fully appreciate the worth of Rafinesque, a naturalist of the 19th century, it would be necessary to consult his major works besides his *A Life of Travels* under review here. A perusal of his accounts of his travels does, however, help one in getting a glimpse into the life and doings of a versatile and untiring worker. Although it may appear to a casual reader that his interest lay in many fields of knowledge, yet it is clearly evident that the study and classification of plants, fishes and shells was the most important among them and received his best attention. His life was devoted to a never-ending quest in search of plants, shells, fishes, minerals, etc., and in the description and classification of the material collected during his excursions. Wherever he went, whatever other occupation for profession he undertook for the sake of earning a living, his insatiable desire to wander over the countryside in search of plants continued nearly to the end of his life.

Rafinesque travelled widely over North America and Southern Europe and wrote at length on the flora of the countries visited by him. Yet he never received his just due from his contemporaries. He was considered by them as eccentric, unreliable and unscientific in his judgment. So bitter was the feeling against him that he could never get any recognition for his labours by the orthodox men of science of his day barring perhaps a few exceptions. But Rafinesque's was a bold and indomitable spirit that could not be quenched with disappointments, defeats or disaster. He continued to work to the end in his own way and had to publish many of his works at his own cost.

Rafinesque first visited America in 1802 and returned to Europe in 1805. He settled down in Sicily where he stopped for ten years and worked a good deal on the local flora. Later forced by circumstances he returned to the United States for the second time when a great disaster overtook him. His work of twenty years of the best part of his life, comprising thousands of collections of plant species, shells and fishes; his manuscripts of many years of painstaking work were all lost in a shipwreck on the coast of America. But this did not deter him from beginning all over again and working for another two decades to contribute to the knowledge of the flora, the ichthyology and conchology of eastern North America.

Rafinesque himself believed that some day his labours would receive their just due. In vindication of his contribution to the natural history of eastern North America during the 19th century comes the following appreciation of this versatile man whose intelligence bordered on that of the genius. Prof. Elmer D. Merrill, an eminent botanist of international renown who writes the foreword to the above republication of Rafinesque's travels, says, "In spite of Rafinesque's idiosyncrasies, in spite of his careless work, in spite of his constant and often caustic criticism of his associates, much that he accomplished was worthwhile." In republishing *A Life of Travels*, the *Chronica Botanica*, a journal devoted to the science of biology, has but given the meade of praise and recognition that was Rafinesque's—a descriptive biologist's due—in the 19th century.

L. S. S. KUMAR.

PSYCHOLOGY AND EDUCATIONAL SCIENCE*

IN his address, the President referred to the problem of Language and Education in India and clearly indicated the scope of the problem and the course the controversy has taken, finally giving his suggestions for solving the problem. He traced the history of the century and a quarter-old problem in brief and pointed out how Dr. West and Mr. Paranjape introduced the element of objectivity into the problem, by publishing some statistical data. Referring to the introduction of the option of answering History and all Classical Language papers of the Matriculation Examination of Bombay University from 1925 onwards, either in English or in their mother-tongue, Dr. Kuppuswamy gave an account of the Analysis of results of 1929 Matriculation Examination made by Paranjape. He reported "that the median marks in history of those who answered in their mother-tongue was 67·6 whereas the median for those who answered in English was only 59·8". He concluded that there was no relationship between the extent of vernacularisation and weakness in English.

Then Dr. Kuppuswamy referred at length to the scheme of teaching the different subjects in High School through the mother-tongue as the medium of instruction started in Mysore in 1931, when History and Geography were taught in Kannada in some of the High Schools. By 1938 all the subjects were taught in the mother-tongue. He quotes the Deputy Director of Public Instruction, Mysore, to have stated in his report, "In fact the pupils with vernacular medium have secured a better percentage of passes as well as higher marks in English".

Dr. Kuppuswamy then refers to the statistical study regarding the effect of the change of medium of instruction upon college performance, taking into consideration the performance in the Intermediate Examination of candidates whose medium of instruction for the S.S.L.C. was Kannada and those whose medium was English. He finds "that in average marks in English there is a difference of 3·7 marks between the English medium Group and the Kannada medium Group". Finally he concludes barring the two subjects, English and Economics, which is a new subject of study, the continuation of English medium has not been a source of advantage to the English medium Group, nor the change from Kannada to English a source of handicap for the Kannada medium students. That is, the performance of the two groups in the College Examinations is about the same though the medium of instruction was changed with respect to some. Further this investigation clearly brings out the fact that there is a confusion in the minds of people concerning the "Knowledge of a Language" and "The Language as a medium of instruction".

Referring to the general belief that with the introduction of the mother-tongue as the medium of instruction, there may result a lowering in the standard of the knowledge and efficiency in English Language the President stated that the knowledge of the English language was not lowered when the medium of instruction was the mother-tongue, so long as English is taught as a language subject. The difference between the two groups with respect to marks in English probably indicates that greater attention should be paid to the teaching of English language for the Kannada medium students than what is being done now.

The concluding part of the speech referred to very useful remarks regarding the teaching of the mother-tongue and the problem of bilingualism in India.

* Abstract of Dr. B. Kuppuswamy's Presidential Address to the Section of Psychology and Educational Sciences, Indian Science Congress, Nagpur, 1945.

INDIA'S POSITION WITH REGARD TO HER COAL RESOURCES*

THE Presidential Address commenced with a review of India's coal reserves in relation to world resources. A brief reference was made to the formation of coal, its micro-structure, physical and chemical characters, and to the system of classification of coal as adopted by the Indian Coal Grading Board. A more detailed account was given of the occurrence of sulphur in coals and on methods of desulphurisation. It was suggested that low temperature coke industry, gas industry, by-product chemical industry, and pulverised coal firing should be introduced in an increasing measure for the proper utilisation of the different grades of Indian coal.

The problem of coal conservation was next discussed and a plea made for the introduction of vertical rotation of working, enforcement of complete stowing, and for the total stoppage of partial grading. Stress was laid on the proper utilisation of the different grades of coal for specific purposes, and the suggestion was made that the Railway Board should utilise inferior grade non-choking coals by introducing pulverised coal-firing in locomotive boilers, and thus release high grade coking and non-coking coals for more important uses. It was recommended that, in order to ensure maximum conservation of India's limited reserves of coal, there should be greater State control and intervention, and that malpractices should be stopped by strict legislation so that the coal industry might be placed on a sound footing; further, that the Central Government should adopt a *National Mineral Policy* and appoint a central advisory technical body like the National Research Council for working out the details.

The address concluded by referring to the serious lack of encouragement on the part of the authorities in the matter of teaching of geology—a subject of great importance and utility. The attention of the Government and University authorities was drawn to give this matter the earnest consideration it deserved, and an appeal was made to them to take immediate steps to improve this unhappy position, and to make adequate provision for proper training of students so that a larger number of qualified geologists and mining engineers would be available for rendering greater and more useful service to India.

* Abstract of Dr. N. N. Chatterjee's Presidential Address to the Section of Geology, Indian Science Congress, Nagpur, 1945.

SCIENCE NOTES AND NEWS

The report of the Director of the Pasteur Institute, Coonoor, for the year 1943-44 embodies an account of the results of routine and research activities. The Institute has carried antirabic treatment for human patients and for animals and details of statistical analysis of the number of cases receiving treatment during the year under review has been presented. Besides, the Institute has also carried out on a large-scale, routine laboratory examination for the benefit of hospital, dispensaries and practitioners. The research work of the Institute mainly consisted of investigation in Rabies and Tropical Eosinophilia. The relationship of the parasite originally found in the mid-brains of guineapigs experimentally infected with rabies street virus to the Negri bodies has been investigated and the suggestion has been put forward that Negri bodies may represent a stage in the life-cycle of the parasite. Clinical and laboratory findings in cases of Tropical Eosinophila suggest the possibility of an infection being responsible for the syndrome.

The Nutrition Research Laboratory during the year under review carried out work on the analysis of foods. Extensive investigations have been carried out on 'anti-thiamin' factor present in certain cereals. The Pyridoxin (vitamin B) content of a number of foods has been determined, using the insect larvæ technique.

Works on experimental fluorosis and investigation into relationship between dental caries and fluorosis have been continued clinical and field investigations on "nutritional diarrhœa" and infantile beriberi in Cocanada have been carried out. Educational and advisory work of the Institute were continued.

The Thirty-Seventh Annual Report of the Central Committee of the Pasteur Institute Association which appears in the latter part of the volume under review records the statements of receipt and payments, the manufacturing and trading accounts, the profit and loss account and the balance sheet.

One of the achievements of the Khandesh Cotton-Breeding Scheme, which aims at increasing the ginning percentage of the prevalent cotton strain (known as Jarilla), is that quality yield was produced. This was possible by hybridizing Jarila strain with a higher ginning cotton. The synthetic cultures so obtained are in their seventh generation this year. Results in the past three years show that three of the above cultures gave 2 to 4 per cent. more ginning than Jarila, and also appeared to be better yielders. Their trial on large-scale in different places is under way.

An improved strain known as Wagator has been recently released by the Cotton-Breeding Station, Viramgam, for multiplication and spread in the Wagad tract of over three lakhs acres in Ahmadabad District where a scheme for the improved Wagad cotton is financed jointly by the Indian Central Cotton Committee and the Bombay Department of Agriculture since May 1937. Wagator cotton is a synthetic type derived from a back-cross, being the quality cotton of South Gujrat. This is superior to local Wagad in yield of Kapas per acre, ginning percentage and spinning capacity. It is further capable of spinning better than local Wagad. Long-stapled, silky, Close-Bell races of Iran, outstanding Surtee Broach types, and early cottons from Russia have been extensively used in crossing with suitable Wagad types since then. As a result of this work, several promising types are now on hand. Experiments have shown that a cotton superior to Wagator would soon become available for the Wagad tract and which would be more profitable to grow.

With a view to take advantage of the provision made in the budget of the Central Government to allow cost incurred on research to be accounted as debit expenditure for purposes of the Excess Profits Tax, the Ahmedabad Mill Owners' Association has decided to start a Research Institute of Textile Technology at a cost of about 65 lakhs.

It is understood that the Government of India have constituted an industrial panel to examine and make recommendations regarding the manufacture of machinery for various industries, such as textile, sugar, paper, mining, cement, chemicals, etc. The Chairman of the panel is Mr. G. L. Mehta and among the members are Mr. P. F. S. Warren, Mr. Kirloskar, Mr. Mulgaokar and Mr. K. K. Birla.

With a view to meeting the increasing demand from Provinces and States for trained personnel in Veterinary Science and Animal Husbandry, the Government of India propose to increase the existing facilities at the Imperial Veterinary Research Institute at Izatnagar with effect from April 1945. The following courses of instruction are contemplated at the Institute:—(1) Poultry Course for four months; (2) Farm Manager's Course for three months; (3) Advanced Animal Husbandry Course (8 months); (4) Associate Diploma of the Institute (2 years); and (5) Specialized Training of Students in Research Methods.

In connection with post-war development plans, facilities for imparting specialized training at the Institute exist and it is proposed to admit 24 students, 12 for Animal Nutrition Research and 12 for Poultry Research.

A University Grants Committee, on the lines suggested in the Sargent report for post-war education in India, has been appointed by the Government of India.

The following students of the Imperial Agricultural Research Institute, New Delhi, have been awarded the diploma of the Institute (Assoc.I.A.R.I.) after completion in September 1944 of the two-year post-graduate course:—

Agricultural Botany and Plant Breeding:

(1) Parmanand Swarup Bhatnagar, M.Sc. (luck.), (2) S. Murtaza Hasan, B.Sc.Ag. (Agra), M.Sc. (Ben.), (3) Clarence Arthur Gideon, B.Ag. (Bom.), (4) Balabhadra Misra, B.Sc.Ag. (Nagpur), (5) Amar Nath Khanna, B.Sc.Ag. (Agra), M.Sc. (Ben.), (6) Ranjit Singh, B.Sc.Ag. (Punj.). *Entomology*: (1) Girdharilal Naraindas Bhatia, B.Ag. (Hons.) (Bom.), (2) Rattan Lal, M.Sc. (Punj.). *Mycology and Plant Pathology*: (1) Jagadisha Chandra Raghunath Mhatre, B.Sc. (Bom.), (2) C. S. Ramamurthy, B.Sc. (Hons.) (Mad.). *Agricultural Chemistry and Soil Science*: (1) Nayani Veera Mohana Rao, B.Sc. (Andhra), M.Sc. (Ben.). *Sugarcane Breeding and Cultivation*: (1) Hassan Luqman, B.Sc.Ag. (Agra), M.Sc. (Ben.), (2) Gursham Singh, B.Sc.Ag. (Punj.), M.Sc. (Ben.).

The Government of Mysore have sanctioned the constitution of a Board of Agricultural Research, with the Minister of Agricultural Research as Chairman, the Vice-Chancellor of the Mysore University as Vice-President, and the Director of Agriculture as Secretary and Principal of the Central College, Bangalore, Heads of the Scientific Sections of the University and Heads of the Sections of the Department of Agriculture as members. The Board will co-ordinate the results of scientific and agricultural research, and see to the applicability of advanced scientific knowledge in practical agriculture.

The Nawab of Chhattari, President of the Nizam's Council, in a message to the inaugural meeting of the Hyderabad Post-Graduate Association of the Study of Homeopathy, expressed appreciation of the attempt on the part of qualified medical practitioners to understand parallel schools of medicine. He said: "Knowledge is the heritage of all mankind and it is the sacred duty of all interested in the well-being of their fellowmen to seek knowledge from every possible source. The various systems of medicine contain some valuable truths, and it is for us to invoke the help of science to sift and collect truth—whatever the source, India is a poor country and has a very large population. One of her greatest needs is to find means of relief for her ailing millions within her economic resources."

A committee is to be appointed to advise the Government of India on the steps to be taken to establish the manufacture of penicillin. This was one of the decisions taken at the Eighth Meeting of the Governing Body of the Council of Scientific and Industrial Research, held on March 18, the Hon. Sir Ardeshir Dalal, Member for Planning and Development, presiding.

The Government of India have decided to set up a Central Waterways, Irrigation and Navigation Commission, a Central Fact-finding, Planning and Co-ordinating Organisation which will examine the potentialities of India's rivers and assist in the co-ordinated and multipurpose development of rivers passing through more than one Province or State. The Commission will be available to advise the Central, Provincial and State Governments on waterways, irrigation and navigation problems throughout the country. It will conduct surveys and investigations to secure planned utilisation, control and regulation of water and waterways in consultation with Provincial and State Governments. The Commission will advise the Centre in respect of principles governing water rights, inter-Provincial disputes and on the appropriate basis of agreement between the parties in dispute. It will also advise the Central Government in regard to the settlement of priorities as between various projects.

The Governing Body of the Indian Research Fund Association, at its annual meeting, approved a programme for medical research for 1945-46, as drawn up by its Scientific Advisory Board, and sanctioned the continuation of 35 research schemes costing about Rs. 6½ lakhs and fourteen new schemes estimated to cost over Rs. 81,000.

A clinical research unit is being set up at the Tata Memorial Hospital, Bombay, and a Clinical Research Advisory Committee will shortly be appointed to draw up a programme for clinical research in India.

The Government of Madras have subsidised a scheme for the investigation by the Indian Institute of Science, Bangalore, of the mechanism of the microbiological formation of sulphur in Kona, Kistna District.

MAGNETIC NOTES

Magnetic conditions during March 1945 were slightly more disturbed than in the previous month. There were 17 *quiet* days, 12 days of *slight* disturbance, and 2 days of *moderate* disturbance, as against 10 quiet days, 20 days of slight disturbance and 1 day of moderate disturbance during the same month last year.

The quietest day during the month was the 22nd and the day of the largest disturbance the 28th.

The individual days during the month were classified as shown below:—

Quiet days	Disturbed days: Slight	Disturbed days: Moderate
1–4, 7, 9, 10, 13, 17–19, 21–23, 25, 30 and 31	5, 6, 8, 11, 12, 14–16, 20, 24 27 and 29	26 and 28

No magnetic storms occurred during the months of March in 1944 and 1945.

The mean character figure for the month of March 1945 was 0·52 as against 0·71 for March 1944.

M. PANDURANGA RAO.

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SCIENCE AND INDUSTRY IN U.S.A., U.K. AND CANADA*

ALMOST the first thing that we realised on reaching U.K. was that the Universities were devoting themselves entirely to those lines of work which were of direct interest to the war effort. As a matter of fact, no teaching work, in the usual sense, was being carried on in any of the Arts faculties. In Science, only such subjects were being taught which either prepared the candidates for the armed services or were of immediate application in connection with the war effort, and all the learned Professors, whether they were practical science men or mathematicians, were engaged in scientific war work. Those who were not working in the laboratories were engaged in interpreting, correlating or statistically examining the data collected by experimental workers and analysing them with a view to arrive at correct interpretation of the results in furtherance of the war effort. We were often questioned by people, who wished to know something about India, as to why the scientists in India devoted less attention to practical applications and were much more interested in the theoretical sciences like mathematics, mathematical physics and astronomy. My friend, Professor Saha, was questioned as to why he interested himself more in the heat of the stars rather than in the manufacture of thermometers and thermocouples to measure heat. They asked us why, when we had an eminent Nobel prize winner amongst us, who had worked all along in optics, we could not manufacture either a lens or a prism. How was it, they argued, that while two of us were Fellows of the Royal Society and specialists in Magnetism, we could not produce electrical machinery or even a permanent magnet. These were significant questions which showed the trend of the present-day scientific thought in Great Britain.

The danger which constantly menaced life and work in England during all these years of bombing and the V-weapons did not frighten away the spirit of science from that country. On the other hand, it gave the scientist a new courage, as a result of which England has now to her credit some most outstanding discoveries which were achieved during this period of travail. As examples, I may just mention that the medicinal use of Penicillin was developed in that country during this war and the actual pilot plant procedure was worked out during the worst days of the battle of Britain, the radio location and the Radar—the instrument by which enemy planes are located by means of short radio waves—were similarly developed under conditions of great difficulty. At least one plastic material which is already playing a very important part was discovered in England during the war. This plastic called Polyethylene, has been obtained from the organic gas, ethylene, by linking together the simple ethylene molecule consisting of one carbon and two hydrogen atoms into giant groups of 2,000 or more molecules under extreme pressure at high temperature. This remarkable resin is flexible and tough and has most extraordinary electrical properties, which find their chief uses in high frequency electrical equipment where it combines negligible power loss with ability to withstand extremes of temperature. In fact, it can be said that but for the discovery of this synthetic plastic during the war, it would have been impossible to make any real headway with the manufacture of Radar equipment for the radio location of aeroplanes. It is a common belief that the Battle of Britain was won by the Physicist through the discovery of Radar. It would be equally true to say that the Chemists have not been far behind, for, by making this synthetic plastic material available they made the manufacture of Radar equipment possible.

England has taken vast strides in scientific research; this goes greatly to the credit of British ingenuity and skill in science. But there is one shortcoming in England which one irresistibly notices in comparison with America. The trouble with England is that Industry in that country is not yet research or technically minded to the same extent as it is in America and thus large-scale process-

* Extracts from an address delivered by Sir Shanti Swarup Bhatnagar at the Central India Centre of the Institute of Engineers (India), on Thursday, the 29th March 1945. The Hon'ble Sir Ardeshir Dalal, Member for Planning and Development, Government of India, presided.

ing in England lags behind pure scientific work. It can, perhaps, be freely admitted that while some of the most important discoveries mentioned above like Penicillin, polyethylene, radar, etc., originated in England, they had to go to America for immediate large-scale production. The U.S.A. scientists and technicians have perfected to a high degree of efficiency that process of intimate co-ordination between science and industry which is so essential for any large-scale production.

We noticed in England that the Industrial laboratories and the laboratories of the Factories, which are engaged on war work, were gradually being remodelled on the liberal scale which is the feature of American research organisations. Large as well as small firms are becoming research-minded and they are employing research Chemists and Physicists to produce new and better things. The scientific workers in U.K. industries were now busy devising methods by which it may be possible to put discoveries made in the laboratory on a large-scale production within a reasonable time.

Of the great many discoveries made during the war-time, I have to restrict myself to describing only a few of the more important ones. Amongst the most notable American achievements in Metallurgy and Chemistry may be mentioned:

(1) Manufacture of Aluminium from clay and the development of new Magnesium-Aluminium alloys.
(2) Advances in Magnesium technology, particularly the process of recovery of magnesium from sea-water.
(3) Development of a method of continuous pouring of an ingot of aluminium up to any desired size, which has made practicable the continuous rolling of aluminium on a large scale.
(4) Making of a new National Emergency steel (N.E. steels) whose main characteristics are lean alloy contents, and better tempering by quenching in oil or salt-baths.
(5) Development of high temperature-resistant steels which are used in super-chargers, gas turbines, jet propulsion devices.
(6) Gas turbines, which when fully developed, will displace both large diesel units and small steam turbines.
(7) Centrifugal casting of metals by means of which alloys can be made in non-forgeable and non-machinable grades.
(8) Powder metallurgy.
(9) Sintered carbide tools.
(10) Plastic bonding of metals.
(11) New electrolytic tin plating process which replaces the old dipping method.

One of the most interesting developments in the chemical field is the growth of the British war-time sulphuric acid industry. The process of making sulphuric acid from gypsum derives its main importance from the fact that a Portland cement is produced as a byproduct. This method has enabled the United Kingdom to increase its acid production to the extent of double of pre-war output. The large quantity of cement produced in this process has resulted in considerable reduction in the cost of sulphuric acid.

Penicillin furnishes an example of a product discovered by two English workers, Fleming and Florey, which could not be developed into large-scale method until America took up its production. In hardly two years' time the manufacture has now reached a figure such that the drug is freely available for all war needs and in somewhat restricted manner for civilian use also. Side by side with increase in production, the price has been reduced to less than a quarter of 1943 figure. It is interesting to note that there is one single plant in America which is preparing something like 90 per cent. of the world's production of this drug, the rest 10 per cent. being made in 26 small factories in America, Canada, England and Russia.

I have already mentioned some features of the progress in the technique of metallurgy. The new method for the manufacture of aluminium from clay has changed the face of aluminium industry. Similarly the process of reclaiming magnesium from sea water marks a revolutionary change in the metallurgy of this material. The cheap production of magnesium by this new method has led to some remarkable developments in the alloys of this metal with aluminium. Some of these new alloys have a tensile strength comparable with that of steel and this fact together with their lightness has led to their extensive use in aircraft construction. The production of the alloys of magnesium and aluminium has been put on new lines which promise to be of great interest to the metal kingdom.

Synthetic rubber is another industry entirely developed during the war. Several methods of making synthetic rubber and rubber-like resins from coal are in active utilization. The fact that we are short of natural rubber makes these discoveries of the greatest value. I do not suggest that synthetic rubber has sealed the future of natural rubber or that the allied armies need not win back the rubber fields from the enemy hands. What I wish to say is that there will be sufficient synthetic material available for supplying every requirement in which rubber is used, even if the natural sources are not available for sometime. We saw many factories and several laboratories where further developments were being made on a big scale.

One of the most significant laboratory achievements of the recent times is the success in the replacement of certain carbon atoms in the molecule of some resins by those of silicon. Silicon most abundantly occurs in combination with oxygen as sand and an organic compound of silicon has been made use of to replace carbon from the usual type of substances used in making plastics. The new resin called *silicone* has been found to have some remarkable properties. Used as an insulating varnish, it bids fair to revolutionise the electrical industry. Merely treating the surface of cotton, paper or glass with it, leaves a water-repellent film which can withstand washing, dry-cleaning and considerable abrasion. Ceramic insulators treated with this varnish are used in aircraft radios as they are not made conducting by the disposition of

moisture on them. Silicone oils stay fluid even at very low temperature and are still usable upto 400 to 500° F. Made into rubber-like materials, silicones are proving valuable as in superchargers and searchlights, where their heat resistance enables them to perform heavy duty under which other materials break down. Insulating and heat-resisting properties of this resin are higher than those of other known resins, and as such it is bound to play a very important part in the Electrical Industry for making water-proof insulating material which can operate continuously at high temperatures for long periods. This has already led to considerable reduction in the size of electrical motors and generators. The General Electric Co., Schnectedy, U.S.A., has evolved another interesting material of this very type. This resin has the additional virtue of being lighter than water, and so it is finding important uses by the Navy. Because of its resistance to heat and moisture it will be a great asset not only to the electrical industry in general but also to the water-proofing industry.

Plastics in America have found use in the shape of lovely colourful jewellery. The coat-hanger in green is made from a plastic resin. It is flexible, light in weight, fits in the wardrobe quite easily and is available in a variety of beautiful pastel colours. The 'pearl' necklace has plastic beads with iridescent plastic paints. There is some other jewellery, too, with plastic emeralds and rubies which may one day be as good as the natural stones. The colourful ladies' handbag is again a plastic product. Another very important thing, which probably many have noticed, is a Chevrolet car gear-wheel. It is as tough as that made of steel but has the valuable quality that it does not make noises which steel gears do. An idea of the extent to which machine and other parts are being made from plastics can be gathered from the fact that an aeroplane to-day has over 1,000 parts made of plastics and a battleship over 50,000.

I shall only make a passing reference to the unburstable containers and jettison tanks. It may be known to some of you that one of the things which we did early during the war was the production of unburstable containers and jettison tanks. These were made from cloth, jute and plastics. These were tested and found to be good by the army in several trials. As a matter of fact they were so good that a British firm in Calcutta was interested in their manufacture in this country. When Calcutta became a danger zone this scheme was abandoned. That tank, which stands vertically, is a 60-gallon tank prepared by us. These were shown to the Engineer-in-Chief in India and to the R.A.F. who were deeply interested and desired that these should be developed on a large scale. Unfortunately, owing to our handicap in putting things on a large scale and also on account of the fact that, as far as England was concerned, jute was not available there, this work could not be developed further. The production was later put on a large scale in America and large quantities were manufactured to drop supplies from air.

I should not at this stage omit to mention that the co-operation of the Engineer and the laboratory worker is of the utmost importance, and they should work shoulder-to-shoulder. In America we found that the Engineers and the Chemists were closely linked together and they worked together in perfect harmony. Unless this combination takes place here and we learn the value of scientific collaboration, it will not be possible for us to make any real progress in industrial development or even in the realm of scientific inventions, because howsoever good an invention may be, the public get interested in it only when it finds application in the things which they know and find useful.

Another development which impressed us very much was the large-scale industrial production of electrical equipment. When I went to England I was under the impression that so far as the hydroelectric developments were concerned, Germany, Norway and America were, so far as the hydroelectric developments were concerned, the last word on the subject, and we found it difficult to believe that even during the war England had developed a very strong industry. We noticed at the Metropolitan Vickers and the English Electric Co. that very large-sized power plants were being constructed.

As an example of things to come, I would like to draw the attention of my audience here to the new post-war Ford car. Those who are now getting industrially inclined with respect to the manufacture of cars in this country may take a peep in the future so that they may not lag behind in this new industry. Plastic sheets employed in the fabrication of the body of the car are made from material of which we have been very proud of in our laboratories of the Council of Scientific and Industrial Research, namely, jute or canvas cloth and plastic. Pressed in moulds the material can be made to take any shape so that the car should be given a streamlined or any other shape. This is the car which is going to be put on the market as soon as the war is over.

America has got a great many laboratories with the most up-to-date equipment in apparatus and facilities. In fact, the equipment of American laboratories has been a distinguishing feature of that country for many years. Among the most notable of these, I may mention the R.C.A. laboratories in Princeton, the Bell Telephone Laboratories in Summit, the Chemical and Engineering and the Technical and Scientific Laboratories of the North-Western University at Evanston, the Geophysical Laboratories of the Gulf Research Co., which have contributed more to the material wealth of America through oil than any other research organisation, the Shell Development Company with its new plastics laboratory and the Standard Oil Co. Laboratories where fluid catalysts are used for purposes of cracking and polymerisation.

We also visited various other scientific organisations and laboratories, such as the Massachusetts Institute of Technology, the Mellon Research Institute, the Batelle Memorial Research Laboratory, the privately owned Universities, the State-run departments such as the O.S.R.D., and the State Universities of America. A new feature of the American laboratory building practice is that the inside

space is now provided with removable walls which enable room space to be altered at will. In the new R.C.A. Laboratory, and the new Bell Telephone laboratory on Murray Hill near New York, one could convert a laboratory room into any size according to requirements within a few minutes. As a demonstration of quick practice we were shown conversion of a room in about ten minutes into something substantially different.

America is the one country in the world which could be said to have solved the problem of poverty and it struck us as a wonderful thing that we did not come across a single badly dressed man. I was, perhaps, the second worst dressed man in America—the pride of first place going to another member of our delegation. We found even the working class well dressed, cheerful and happy. The labour is held there in high regard and is not branded or looked down upon as inferior. This is the kind of spirit which has made the Americans a great nation.

I must not forget to say that, as far as agriculture is concerned, America is really supreme. All the agriculture there is being done by power. The farmer is an educated man and he knows the practical value of fertilisers, rotation of crops, insecticides, grading, marketing, etc., in fact, of all those things which, for us in India, exist only in text-books and nowhere in practice.

In America the natural resources of the country have been fully harnessed and that country should serve as a model to all countries of the world for development of power and its utilisation in automatised industries. Two most notable examples of this are the Boulder Dam and the Tennesse Valley project. A few facts about the Boulder Dam may be interesting here. The Boulder Dam is built across the Colorado river which rises in the rocky mountains and rolls for 1,700 miles through the South-Western States to its mouth in the Gulf of California. This river drains a rugged mountain and desert region covering about 2,44,000 sq. miles, which is roughly one-twelfth of the total area of the country. Like many rivers in India, it has alternated in a vicious cycle of flood and draught, wiping out millions of acres of crop some years and abandoning them to the scorching sun in others. To hundreds of thousands of people who lived directly under its threat this treacherous river was for a long time a symbol of the God of Destruction. It was in 1928 that the United States Government resolved to harness the aid of science to put this river in its proper course and the Congress authorised the project for the construction of a dam of colossal dimensions astride the Black Canyon where the Colorado river constitutes a boundary between the States of Arizona and Avada. The chief object of these engineering operations was to first control the floods and to build a reservoir of water for domestic use and irrigation and to generate power at low cost. The work was completed within five years, between 1930-1935, two years ahead of the scheduled time. The total cost was 165 million dollars. Some of the remarkable features of the project were: Construction of four immense bunds through the Canyon walls, diverting the river from its course, building two huge coffer dams, blasting out the dam site and fabricating the dam and power plant in solid blocks of concrete. In this operation they used 4,40,000 cubic yards of masonry; 50 lac barrels of cement; 80 lac tons of sand, gravel and cobblestones; 6 crore 30 lacs tons of structural and reinforcing steel; 2 crore 10 lacs pounds of gates and walls; and 840 miles of pipe.

To-day, the Boulder Dam stands as one of the greatest feats of engineering and a monument of the vision of the United States of America. Towering 726 feet above the river bed, stretching 1,240 feet from the water wall, measuring 660 feet at its base, it runs the world's' highest tank. During the eight years of its existence Boulder Dam has altered the face and made the fortunes of the South-Western States in the U.S.A. It irrigates 20 lacs of acres of farm land in South California, Arizona and Avada. The power plant produces 30 lac kW of cheap power which has lit dozens of cities and brought comfort and prosperity to large areas in that locality. Similar and more important developments have been made in the well-known T.V.A. regions.

Coming to Canada we felt that this great dominion of British Empire shares with America the feeling that once science and technology are properly developed, poverty will vanish by itself. As a matter of practical example, the Canadian Government have brought into being under the National Research Council of Canada, an organisation called the Research Enterprises, Ltd., whose function is to develop on a large scale the discoveries that have been made by the Council during the war. The motto of this organisation is "What is difficult we do just now. What is impossible we take sometime to do." Within the last four years the Canadians have done wonderfully well in every phase of activity. In a nutshell, Canada is trying to follow in the footsteps of America. The feeling in that country is that politics ought to be relegated to a minor position and more attention should be paid to developments. This may or may not apply equally vigorously to India; there is no doubt that science has never been tried by the people or by the Government on a large enough scale to banish poverty from this land.

Finally, I must say that in America we found a great deal of desire on the part of Americans to develop weaker nations and that desire is equally shared in Great Britain and the recent announcement of Lord Nuffield with respect to motor car industry in India may be cited as an example. The U.S.A. have already invited a large number of Chinese students to that country and have awarded scholarships to train them as scientists and technicians to take up the problem of industrial development of China. A complete programme of Chinese development, if catalogued, will run up to some 550 pages. Unless we plan and develop in a really big way both in agriculture and industry, there is no future for us, and we shall never be able to have our proper place in the comity of nations.

TIME, SPACE AND THE MENTAL MACHINE

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SOME years ago as a result of putting together a large number of results obtained by me through stimulating beating hearts with adrenaline I discovered a new law of natural stimulation which reads as follows:—"In living structures their natural stimulation according to its strength causes a corresponding development of energy which first remains in being and then dissipates after the stimulant has ceased to act."[4] But, after discovering that law as the result of stimulating living structures, I found that my motor car and bicycle obeyed it. So do all other inanimate structures which move on the face of this earth as the result of impressed force. And since these inanimate objects obey this law because of friction, I deduced that living structures obeyed it likewise. That is to say, the natural stimulation of living tissues gives rise to increased movements of structures with surfaces.[3]

This law can be verified physiologically by the non-physiologist through his vision. He already takes it for granted that the energy developed within him as a sensation has some accordance with the strength of the stimulant, which is light. He probably knows that the cinema depends on the capacity of the sensation-energy developed thereby first to remain in being after the stimulant has ceased to act. Thereafter it dissipates. To verify the law with a motor car one simply puts the 'phenomena' of motoring into the terminology of physiology.[3]

Now it is typical of the reaction of a living tissue to stimulation that the energy of discharge is out of all proportion to the energy used in stimulation. This 'property', it may be observed, is possessed by motor cars wherein the energy of stimulation, as pressure on the accelerator pedal, is out of all proportion to the energy discharge or momentum thereby developed by the car. There is, therefore, no question of the stimulating agent supplying energy by its own oxidation. Moreover, sodium chloride is a stimulating agent,[1] and it is certainly not combustible even by living tissues. I have consequently to seek self-propelled bodies as the units which move faster when living tissues are stimulated to increased activity, or increased capacity for function.

So far as the agency of propulsion is concerned, I have got down to structures at the most of the size of a colloidal particle, and that rules out all organised propulsive agents such as flagella, etc. In fact, one is only left with surface tension, the probable source of movement of the amœba. This is a perfectly feasible agent of propulsion, and to utilise it we require units which can oxidise foodstuffs, and in doing so, give rise to metabolic products which can alter surface tension. It is further feasible that Nature should have evolved a unit which produced two classes of metabolic products. The one class should ooze out over the unit's front half and lower surface tension, the other class should ooze out over the posterior half and raise it.

When I first discovered that friction is concerned with natural stimulation then, in view of the overwhelming evidence that colloids have determining roles in excitation processes, I sought in the movement of colloidal particles, because they have surfaces, the source of that friction.[3] Considering also that there is law and order in a beating heart in that it regularly undergoes a cycle of operations comprised of contraction, relaxation, and rest, I visualised something corresponding to this in movements. I, therefore, suggested that these colloids had regulated movements corresponding to those of a body of troops performing drill on a barrack square, as opposed to the 'Brownian' movements of a crowd disporting itself over the same area.[3]

To regulate these movements, however, requires something of the nature of a commanding force to enforce the regulating. One required also something corresponding to change of direction to explain alternations of state corresponding with alternation of contraction and relaxation. But it was also the case that a change of direction, provided movements were in straight lines, required still another force to change the direction. On the other hand, if there were not changes of direction, the setting up of a high state of functional capacity, as such movements in one part of a nerve, say, should automatically be succeeded by a loss of functional capacity in that part, and such is definitely not the case. Moreover, the restriction of travel of these moving elements cannot be brought about by walled boundaries, because a single collision between moving particles in such a confined space would eventually confer on living matter the properties of a gas. Motion in orbits, thus, emerges by exclusion as the nature of these regulated, restricted movements.

Having deduced that, one can straightway consider whether the conclusion is probable, and I consider that the answer to this is yes. At any rate, it seems to me more likely that Nature has a fundamental plan of construction than several. Biologists, however, have no more suspected that living matter is built up on the lines of the solar system any more than physicists and chemists originally suspected that the atom was. Yet, such a structure is the only one that can supply an answer to that obedience of living tissues to Burridge's Law. The protoplasmic atom is one where the satellites move in a medium subjecting them to friction, and Nature conferred what we term life on that system when the satellites were made self-propelled.

We have next to observe that a self-propelled circular body subjected to friction will not keep its orbit, because the outer edge will move faster than the inner and the differences of friction will provide a rotational force. In turn, this will change the direction of propulsion, and so the satellite will move out of its orbit. The actual form of satellite that would tend to keep its orbit in a frictional medium, I leave to the mathematicians to work out. For the present it suffices to rule out circular bodies because that rules out colloidal parti-

cles as the satellites. But, as already mentioned, the evidence that colloids have determining roles in excitation processes is overwhelming. I, therefore, assign to a charged colloidal aggregate the functions of a nucleus.

A colloidal aggregate is capable of reacting in two ways to what physiologists would term a change of environment and what the physical chemist will term a change in the composition of the dispersing phase; it can react either through adsorption phenomena or through changes of colloidal aggregation, or, and more probably, by both. In my book, *Excitability*,[1] I have summed up an abundance of evidence that living tissues do react to an environmental change in such manners as had the marks of an absorption reaction and a change of aggregation, respectively. My findings further indicated that changes of colloidal aggregation and adsorption reactions were the sources of energy for the excitation processes of living structures. There was, however, a significant difference following on change of the composition of the dispersing phase *in vivo* and a change *in vitro* in that with the former there were marked changes in the energy manifestations of the system. An orbital system explains those differences.

According to other work done by me, calcium is the exciting agent of the cardiac exciting apparatus; also, when it does excite, it exercises a coagulative change in the colloids concerned in excitation processes.[1] Earlier work by Macdonald,[5] however, showed that these colloids have abundance of potassium salts adsorbed on them, and that the shedding of these potassium salts into the dispersing phase automatically causes re-dispersion of the colloidal aggregates. That is to say, the nucleus of the living solar system is capable of undergoing alternations of neutralisation and re-charging. At the same time it should be observed that calcium does not appear to be the neutralising agent in all excitable tissues. Nicotine is the agent which reveals where calcium acts as the neutraliser, and it provides the evidence that something other than calcium neutralises in the nerve trunk.[1]

Neutralisation of the nucleus of this physiological atom will be followed by disruption of that particular atom, the satellites of which will fly off in all directions, and, since they hold charges opposite in sign to the nuclei, they can be expected to be drawn towards and exert a neutralising action on neighbouring nuclei. That is to say, all neighbouring systems should undergo neutralisation and disruption. This is another way of stating that an excitation should be conveyed in all directions, and it is. We have to note, however, that if the structural conformation of any satellite helps it to keep to a particular orbit, it will not travel in straight lines after nuclear neutralisation, but some wider orbit determined by its own proper configuration and propulsive force.

From this point of view the propagation of the nerve impulse along a nerve is to be visualised as a wave of advancing disruption of physiological atoms followed by their restitution in the rear. We may well indeed find some day that the wider orbit made possible to a satellite by a nuclear neutralisation does not extend beyond one or two atoms, and that it may tend automatically to return to its old orbit as the nucleus recovers its charge. In any case, with all atoms being disrupted and all being reconstituted, any atom should on an average recover as much as it originally lost.

Another point to note about these systems is that adsorption phenomena and aggregation changes taking place at the nucleus are both expressed as changed motion or momentum of the satellites. That is to say, we ought to be able to obtain some evidence that both of these changes ultimately appear to be the same thing. There is evidence to that effect, but before considering it the reader's attention is drawn to certain psychological aphorisms given by me elsewhere. Those aphorisms are:

(1) We do not know what things are, we only know what we believe them to be.

(2) What we believe a thing to be is determined for each of us by the nature of the processes working in our organs of mind and thereby mediating that belief to us.

(3) We are born to believe in the existence of external realities corresponding to the processes at work in our organs of mind, but things are not necessarily so.

Applying these aphorisms to the case of the drunk man, we appreciate that he is drunk because he must believe as faithfully in the results of the altered working of his mental machinery produced by a drug as he did in its normal workings when sober. Likewise, the insane man is insane because he cannot help believing in the truth of what abnormal working of his mental machinery appears to him to reveal.

It is not, however, the habit of men to reflect on the fact that Nature has provided them with a definite type of machinery wherewith to do their thinking, and that in consequence the machinery must be a factor determining what is produced from the facts which are put into it. So far as I can judge, philosophers and mathematicians are the men who have probed most deeply into the workings of this mental machinery. The former have reached the conception that the great realities of nature are time and space. In my book, *A New Physiological Psychology*,[2] however, I have pointed out that our conception of time as a great reality is based on adsorption reactions taking place in the nerve cells of our brains, whereas the conception of space is based on changes of colloidal aggregation taking place in those same colloidal systems which form the machinery for our thinking. I have consequently pointed out that there may be other great realities about which we can gain no conception simply because we have not got the thinking machinery which makes this possible. We should, therefore, be prudent in our negations. Even the importance which scientists are wont to attach to comprehensive theories is an automatic consequence of the mental machinery working as it does.[2]

According to these findings, then, the philosophers have looked outside themselves for external realities corresponding to the capacities of the nuclei of our physiological atoms. The mathematicians have done the same with-

out taking into consideration the point that the machinery with which they do their calculating is a factor determining the products or proofs at which they eventually arrive. Considering also that the seeming importance of comprehensive theories is automatically derived from the nature of this machinery,[2] it seems likely that this machinery will more likely mislead us in the realm of higher mathematics than in ordinary arithmetic, though even in respect of the latter very little deviation from the normal is required to render the machinery incapable of calculating the correct change from a five-rupee note. But what it does then calculate is believed to be the truth! In contrast with this, the existence of lightning calculators, could be held to indicate that the normal machinery is a slow-motion affair.

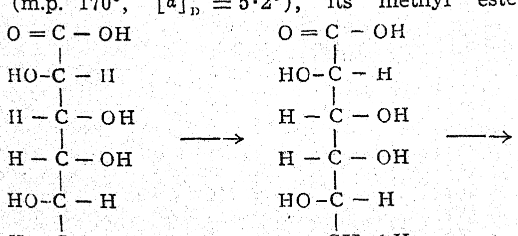
A whole volume, in fact, could be written relative to the part played by the mental machinery in arriving at a mathematical result. It is enough, however, to observe here that the machinery does play a part. We have to observe further that the events taking place in the physiological nucleus are eventually expressed in the one form of altered momentum of satellites. It seems to me, therefore, that the machinery is also built as to lead its possessor eventually to 'discover' that time and space are one. Which point being noted, the reader is left to ponder over the possibility that the modern doctrine of relativity may illustrate the much more ancient Hindu doctrine of Maya.

1. Burridge, *Excitability*. *Oxf. Univ. Press*, 1932. 2. —, *A New Physiological Psychology*, *Arnold*, 1934. 3. —, *Proc. Ind. Sci. Cong.*, 1936. 4. —, *Arch Internal de Pharmacod*, 1938, **59**, 450. 5. Macdonald, *Quart. J. Exp. Physiol.*, 1909, **2**, 65.

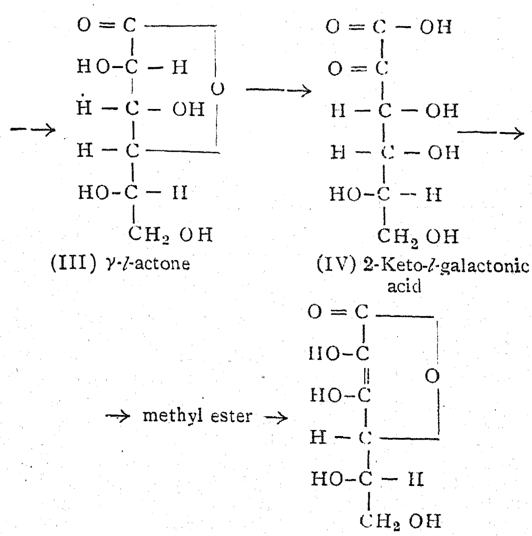
SYNTHESIS OF VITAMIN C FROM PECTIC SUBSTANCES

THE present requirement of vitamin C or *l*-ascorbic acid (V) is met by isolating the substance from fresh fruits and vegetables or preparing it synthetically from sorbitol. A new and a comparatively easier process for the preparation of vitamin C from pectic substances like beet-pulp has recently[1] been developed. The pectic substance is hydrolysed with a commercial pectinase and the resulting galacturonic acid (I) is separated in the form of a difficultly soluble calcium or strontium salt (15-20 per cent. yield). This salt is almost quantitatively reduced with Raney nickel and hydrogen under pressure and the resulting salt of L-galactonic acid (II) is converted by subsequent treatment with oxalic acid to the corresponding γ-lactone (III) (m.p. 134°, $[\alpha]_D^{20} = 78°$) in over 90 per cent. yield. The above lactone is then oxidised in presence of sodium chlorate and vanadium pentoxide to 2-keto-L-galactonic acid (IV) (m.p. 170°; $[\alpha]_D^{20}$ + 5·2°; 25-30 per cent. yield), which by usual treatment with anhydrous methyl alcohol and hydrogen chloride produces the methyl ester (m.p. 145-150°, $[\alpha]_D^{20} = +4·7°$, over 90 per cent. yield); when the latter substance is treated with alcoholic sodium methylate and subsequently ecidified with N-sulphuric acid, it is lactonised and enolised to L-ascorbic acid (vitamin C) (V), identical with the natural product.

The preparations of 2-keto-D-galactonic acid (m.p. 170°, $[\alpha]_D^{20} = 5·2°$), its methyl ester



(I) Galacturonic acid (II) *l*-Galactonic acid



(III) γ-*l*-actone (IV) 2-Keto-*l*-galactonic acid

→ methyl ester →

(V) L-ascorbic acid (Vitamin C)

(m.p. 145-150°, $[\alpha]_D^{20} = -4·6°$ and D-ascorbic acid (m.p. 191°, $[\alpha]_D^{20} = -23·8$) have also been described in this paper.

It is very interesting to note that 2-keto-L-galactonic acid (IV) and its methyl ester on lactonisation and enolisation yield natural ascorbic acid rather than an isomer thereof.

Many of the reactions of this paper and also the formation of furfural and reductic acid from pentoses and heuronic acids have been interpreted in terms of electronic displacement.

The main importance of the paper lies in the fact that it opens a vast possibility for the utilisation of beet-pulp, obtained from sugar industry, as an easily available raw material for the manufacture of vitamin C. If the yield in the oxidation of L-galactono-Y-lactone (III) to 2-keto-L-galactonic acid (IV) is improved, the process will compare favourably with the sorbose process, now utilised for the synthetic production of this important compound.

S. C. B.

1. Isbell, H. S., *J. Research NBS*, 1944, **33**, 45.

LETTERS TO THE EDITOR

THE LIGHT-EFFECT UNDER ELECTRIC DISCHARGE: THE PROBABILITY OF RECOMBINATION

IT has been found by Joshi and others[1] that the conductivity of gases like chlorine when subjected to ionisation by collision under alternating electric fields, diminishes immediately on irradiation. This seems to be a contradiction to the Photo-electric effect in gases and hence it appears to be of the nature of a negative photo-effect.

Without entering into the detailed mechanism of this light-effect, it may be suggested that the familiar photo-electric effect should occur immediately after irradiation. It should not be overlooked that the photo-electric effect in gases becomes complicated due to the fact that the photoelectrons from the walls of any apparatus used are greater in number than those from the gas itself. The shielding of the metal electrodes used for determining the conductivity of the gas is also an important factor. Under such circumstances there should be a net increase in the conductivity due to the photo-electric effect in the gas, the wall effect and the electrode effect. The decrease in conductivity on irradiation suggests that there is probably some mechanism by which a recombination of the ions is taking place on irradiation. It should be remembered that the gas is being subjected to electrical discharge under an alternating field which is most likely effective in increasing the recombination of the ions and the electrons.

It is obvious that the ions and the electrons have to change the directions of their motion in the alternating field and they are continuously colliding with each other at a pressure of 46·5 cm. when the light-effect is reported to be a maximum.[2] The velocity of the ions and the electrons is continuously varying from zero to a definite maximum depending upon the mean free path and the magnitude of the electric field impressed. It has been found that electrons of a definite velocity find the collisional areas of molecules of the gas to be higher than those expected from gas kinetic consideration.[3] Under this increased collisional areas of molecules and the optimum value of pressure of 46·5 cm., the probability of recombination might increase due to the collisions in the alternating field.

The collisions are of the first kind before irradiation where the internal energy of the atom is raised at the expense of the relative translational energy of the collisional partners. The effect of irradiation might be the ionisation of gaseous molecule without dissociation or dissociation of molecule and ionisation of one of its atoms or ionisation of the gaseous atom. After irradiation the collisions are predominantly of the second kind where an excited atom collides with an electron and the latter is raised to a higher energy state and the former loses energy. In an alternating field, the electrons and the excited atoms are moving in opposite directions and in a collision of the second kind under such conditions, the velocity of the electron is decreased instead of increasing. After a certain time depending on the frequency of the alternating field, the electron is subjected to a retardation due to the reversal of the field and its velocity becomes zero. As the initial velocity decreases

due to the collision, the distance the electron would traverse when its velocity becomes zero, also decreases under the retarding field. The decrease in this distance means an increase in the number of times when the velocity of the electron tends to become zero. Since the probability of ionisation by a light quantum is a maximum when its energy just exceeds the ionising potential so that the kinetic energy of the photoelectrons is small, it follows from the principle of microscopic reversibility[4] that the probability of combination is greatest when a slow electron collides with an ion. Under such circumstances, the probability of recombination is increased due to the excess of the electrons approaching a velocity equal to zero and hence there might be a diminution of the discharge current in an alternating field on irradiation.

Whatever might be the true mechanism of this decrease in current on irradiation, it may be emphasised that this light-effect has got several technical promises and applications in the future.

The author is highly indebted to Dr. S. S. Joshi for kindly sending the reprints and the relevant information on the subject.

St. Xavier's College,
Ranchi, B. K. SAHAY.
March 25, 1945.

1. Joshi and Narasimhan, *Curr. Sci.*, 1940, **9**, 536; — and Deshmukh, *Nature*, 1941, **147**, 806; —, *Proc. Indian Sci. Cong.*, Presidential Address, Chem. Sec., 1943. 2. — and Deo, *Nature*, 1944, **153**, 434. 3. Brode, *Phys. Rev.*, 1924, **23**, 664; —, *Ibid.*, 1925, **25**, 636; —, *Proc. Roy. Soc.*, 1925, **109**, 397. 4. Klein and Rosseland, *Z. Physik.*, 1921, **4**, 46.

ON AN OCCURRENCE OF MICA-PERIDOTITE FROM MIRZAPUR DISTRICT, UNITED PROVINCES

THIS note describes the occurrence of a very small and narrow dyke of Mica-peridotite east of Chhipia village which has not been previously recorded. It is probably the westernmost occurrence of mica-peridotites, the known occurrences being more to the east in the Giridih, Jharia and Raniganj coalfields.

The rock is medium-grained, and black in colour with glistening flakes of deep brown biotite. Greenish black grains of olivine altered to serpentine can also be seen. It effervesces with warm concentrated hydrochloric acid indicating the presence of dolomite. The specific gravity of the rock is 2·97.

Under the microscope, the grains of olivine are somewhat rounded, crystal boundaries being observed only in a few cases. The length of the crystals varies between 1·61 mm. and ·53 mm., the average being ·99 mm. Almost all the sections show serpentinisation, with liberation of magnetite sometimes along the cracks. In some cases, the serpentine is further altered to a mineral resembling talc. Ultimately, however, it is seen to be replaced by a fine-grained mosaic of dolomite.

Biotite is remarkably fresh and is strongly pleochroic from light yellowish brown to dark brown. Its flakes enclose grains of olivine giving an ophitic aspect. The flakes vary in

Photomicrograph of Mica-peridotite
Ordinary light × 31·25

length from ·26 mm. to 1·54 mm. In some instances bleaching of the interior is marked.

Augite which is subordinate in amount, is pale-green in colour and has an elongated form. A few small stout prismatic sections of common hornblende are observed. It also occurs in small greenish patches derived by the alteration of augite.

Magnetite occurs associated with serpentine, as inclusions in biotite, and in the form of dendritic skeletal crystals. But the inclusions of this mineral in biotite have well-developed cutline. Ilmenite is much less common and is seen altered to leucoxene. Hæmatite and limonite occur as small specks.

The study of the rock has been made under the guidance of Dr. H. L. Chhibber, Department of Geology, University of Lucknow. To him the writer is highly indebted.

Department of Geology,
Lucknow University, R. C. MISRA.
February 15, 1945.

NEGATIVELY CHARGED FERRIC VANADATE SOL

WHEREAS the positively charged sols of ferric arsenate, phosphate, molybdate, tungstate and borate have been prepared and studied by Grimaux,[1] Holmes,[2] Dhar,[3] Prakash,[4] and Ghosh,[5] no attempt has been made to prepare and investigate their negatively charged sols. In a paper Prakash and Mushran[6] investigated the detailed conditions under which these negatively charged sols can be obtained in this note the results with negatively charged ferric vanadate sol have been recorded.

When ammonium vanadate is added to ferric chloride solution, yellowish white precipitate of ferric vanadate is obtained. It is observed that the precipitated ferric vanadate can be dispersed by caustic soda in presence of glucose or glycerine to yield a clear deep

red sol. If the sol is dialysed until all electrolytes are removed it can be shown to possess a negative charge. By taking the sol in a U-tube with platinum electrodes, and passing a current, it is seen that the sol is coagulated at the anode. The coagulum after being collected and washed is found to contain ferric vanadate. The idea of peptisation can be had from the following figures:—

1·0 to 2·5 c.c. of a ferric chloride solution (corresponding to 30·36 gms. or Fe_2O_3 per litre) when mixed with 1·0 to 3·0 c.c. of ammonium vanadate solution (corresponding to 6·5485 gms. of V_2O_5 per litre) in presence of 0·9 to 3·0 c.c. of 20 per cent. glucose solution requires 1·3 to 4·0 c.c. of N-NaOH (total volume 10 c.c.) to bring about the complete peptisation in half an hour.

1·0 to 2·5 c.c. of a ferric chloride solution (of the same strength) when mixed with 1 to 3 c.c. of ammonium vanadate (of the same strength) in presence of 0·4 to 2·5 c.c. of glycerine requires 1·4 to 3·4 c.c. of N-NaOH (total volume 10 c.c.) to bring about the complete peptisation in half an hour.

Detailed procedure of the study of this sol will be duly communicated.

The auhor is greatly indebted to Dr. Satya Prakash for suggesting the problem and for guidance during the course of this work.

Chemical Research Lab.,
Allahabad University, S. P. MUSHRAN.
April 24, 1945.

1. Grimaux, *Comptes Rend.*, 1884, **98**, 1540. 2. Holmes *J. Amer. Chem. Soc.* 1918, **40**, 1014. 3. Dhar and Prakash, *J. Indian Chem. Soc.*, 1930, **7**, 367. 4. Prakash and Verma, *Z. Anorg. Chem.*, 1932, **205**, 241. 5. Ghosh and Chakravarti, *Proc. Nat. Acad. Sci.*, 1939, **9**, 201. 6. Prakash and Mushran, *Allahabad Univ. Studies*, 1943, **19**, 1.

VERNALISATION RESPONSE OF INDIAN WHEATS

THE six different strains of foreign wheats so far tried by us in Almora since 1938—Holdfast, Little Joss, Yeoman, Juliana and Yorkwin—have all given significant vernalisation response, *i.e.*, earlier emergence of inflorescence in plants from pre-chilled seeds. In both Holdfast and Yeoman[1] a maximum earliness of nearly one month has been observed in normal seasonal sowings of October. A few strains of Indian wheat which have hitherto been tried for vernalisation experiments in different places in India are: Bansi 103, in Poona,[2] I.P. 4, I.P. 114 and C. 13, in Almora,[3] I.P. 114 and I.P. 165, in New Delhi,[4] and I.P.4, I.P. 52 and I.P. 165 in Calcutta.[5] The observed earliness in ear emergence of plants from vernalised seeds in all these wheats, if any, was very slight and statistically insignificant. These observations led to the general acceptance that the cultlivated strains of Indian wheat would not respond to vernalisation on account of their shorter life-cycles.

The results (unpublished) of our vernalisation experiments with crosses between I.P. 4 (Indian wheat) and Yeoman (Cambridge winter wheat), begun in 1939 and still in progress, proved that F_1, F_2 crosses and F_3 selections, all with a much shorter life-cycle than their Yeoman parent, gave very good vernalisation response. This encouraged the hope that there might be some cultivated Indian wheats, after all, which would respond to vernalisation. In 1942, first preliminary experiments were undertaken with 18 pure strains of cultivated Indian wheats—P.8-A, P.9-D, P.499, P.C. 518, P.C. 591, C.Ph. 47, A.T. 38, H.S.W. 3, I.P. 12, I.P. 52, I.P. 80-5, I.P. 101, I.P. 111, I.P. 114, I.P. 120, I.P. 125, I.P. 165 and C. 13—seeds of which were obtained through the courtesy of Dr. B. P. Pal, Imperial Economic Botanist, from his collection at New Delhi. As a result of the encouraging results observed in 1942-43, we (*i*) repeated the experiments with these eighteen strains in 1943-44, and (*ii*) arranged a systematic study, in co-operation with Dr. B. P. Pal, of the vernalisation response of all the available strains of Indian wheats in his collection.

In 1943-44, two sowings were made of vernalised seeds of the eighteen strains listed—one in October 1943, and the other in February 1944. For both these sowings the seeds were chilled for 67 days and were sown with their corresponding controls in similar stages of germination in randomised blocks with four replications. The data of the vernalisation response of the strains of the cultivated Indian wheat in which a significant earliness of over one week was observed in normal seasonal sowings of October, together with their responses in February sowings, for comparison, are given in Table I.

From the above table it will be seen that (*a*) there are strains of cultivated Indian wheat which respond to vernalisation, (*b*) response of different ~~strains~~ varies and (*c*) an earliness in ear emergence up to 27·5 days can be obtained in plants from vernalised seeds of P. 9-D, in normal seasonal sowing in this region. The comparison of the earliness observed in October and February sowings clearly indicates that favourable after-sowing environmental factors—temperature and daily light period—modify, and in some cases, even completely mask, the advantages of pre-chilling of seeds. For instance, (*i*) the earliness observed in P. 9-D and A.T. 38 in October sowing was 27·5 and 20·5 days respectively, while the corresponding earliness in February sowing was 2·68 and 2·50 days, and (*ii*) in February sowing of the other seven strains, no significant earliness could be observed, even in P. 8-A, which in October sowing showed a significant earliness of 19·75 days. Therefore, to explore the practical possibilities of vernalisation for Indian agriculture it would be necessary to observe the vernalisation response of different strains of crops when grown in different climatic regions of India.

Though an earliness of agricultural significance in ear emergence of certain cultivated Indian wheats can be obtained by the use of vernalised seeds, it will be seen from Table II that the number of tillers, the factor positively correlated with yield, observed in both sowings in plants from vernalised seeds, was smaller.

TABLE I

Showing vernalisation response of cultivated Indian wheats, sown (I) October 1943, (II) in February 1944, (C) control plants; (V) plant from vernalised seeds. The number of plants are given in brackets

Strain	Mean number of days for ear emergence				Earliness (days) in ear emergence in (V)	
	I		II			
	(C)	(V)	(C)	(V)	(I)	(II)
P. 8—A	140·50 (33)	120·75 (32)	69·89 (19)	67·78 (19)	19·75*	2·11
P. 9—D	130·00 (34)	102·50 (32)	66·68 (19)	64·00 (18)	27·50‡	2·68†
P. C. 499	124·50 (36)	111·25 (35)	..	..	13·25†	..
P. C. 518	122·75 (37)	115·00 (37)	67·15 (19)	67·46 (15)	7·75*	−0·31
P. C. 591	124·50 (35)	109·75 (37)	67·60 (20)	65·05 (18)	14·75†	0·55
C. Ph. 47	114·25 (39)	94·75 (39)	68·88 (18)	68·94 (16)	19·50*	0·60
A. T. 38	142·75 (37)	122·25 (34)	70·40 (18)	67·90 (15)	20·50‡	2·50*
H. S. W. 3	135·50 (37)	121·50 (36)	71·16 (18)	71·70 (17)	14·00†	0·54
I. P. 12	108·75 (37)	99·00 (38)	69·00 (12)	67·60 (13)	9·75‡	−1·60

* Significant at 5 % level, † At 1 % level and ‡ At 0·1 % level.

TABLE II

Showing number of tillers in plants from control (C), and vernalised (V) seeds. (I) October 1943 sowing, and (II) February 1944 sowing. Number of plants is given in brackets.

Strain	Mean number of tillers			
	I		II	
	(C)	(V)	(C)	(V)
P. 8—A	13·9 (33)	6·3 (32)	7·3 (19)	5·9 (19)
P. 9—D	13·0 (34)	6·6 (32)	5·3 (19)	4·4 (18)
P. C. 499	6·9 (36)	4·5 (35)	..	..
P. C. 518	7·8 (37)	6·0 (37)	6·3 (19)	5·4 (15)
P. C. 591	8·0 (35)	5·6 (37)	7·0 (20)	5·3 (18)
C. Ph. 47	11·0 (39)	7·4 (39)	3·5 (18)	2·6 (16)
A. T. 38	12·9 (37)	6·6 (34)	3·7 (18)	3·3 (15)
H. S. W. 3	15·8 (37)	9·4 (36)	5·0 (18)	4·0 (17)
I. P. 12	10·8 (37)	7·8 (38)	6·5 (12)	4·2 (13)

In view of the observed diminished number of tillers in plants from vernalised seeds, spacing experiments with control and vernalised seeds of P. 9-D, A.T. 38 and P. 591 have now been undertaken in 1944-45, to find out whether by closer spacing similar, if not higher, yield can be obtained by the use of vernalised seeds.

Regarding the systematic study of the vernalisation response of all available strains of Indian wheat, one hundred and fifty strains were vernalised in a Frost Pit[6] in Almora, in 1943-44. An off-season sowing of these seeds was undertaken simultaneously in Almora and New Delhi in February 1944, and a seasonal sowing in October 1944 at both places. The report of vernalisation response of these strains will form the subject of a joint paper with Dr. B. P. Pal, when the data of October sowings become available.

We are obliged to Mr. K. Kishen, Statistician, Department of Agriculture, U.P., for the analysis of the data. The expenses of this investigation have been met from grants received from the Elmgrant Trust, Dartington, England, and the Imperial Council of Agricultural Research, New Delhi.

Vivekananda Laboratory,
Almora, U.P., B. SEN.
January 21, 1945. S. C. CHAKRAVARTI.

1. *Indian Farming*, **1940**, **1**, 55–56. 2, 3 & 4. *Proc. Third Meeting Crops and Soils Wing, I.C.A.R.*, **1940**, pp. 111–41. 5. *Trans. Bose Institute*, 1942–43, **15**, 105–25. 6. *Progress Report, I.C.A.R.*, 1942–43.

STABLE ADRENALINE SOLUTION

Various attempts have been made to stabilise a 0·1 per cent. solution of adrenaline hydrochloride.[1,2] Metabisulphite,[3,4] ascorbic acid,[5,6] glutathione,[7] methylene blue,[8] tryptophan,[9] guanidine,[10] one or other acid[11,12,13,14] has been incorporated into its solution. This prevents the formation of a colour and/or a precipitate[15,16] on storage. Preparation of an adrenaline solution in presence of an inert atmosphere, has no special advantage.[17] The adjustment[3,18] of pH of the final solution, and its maintenance undoubtedly increase[1] the keeping properties but does not secure stability on long storage in the tropics.

But as adrenaline used for therapeutical purpose, is a lævo-rotatory compound and as its other enantiomorphous forms are much less active in pressor action, a change in the rotatory power might also play a part in its inactivation on storage. Haddock[19] noted that at pH 1·4 to 3·7 racemisation was negligible. But working in this direction it has, however, been noticed by us that an adrenaline solution undergoes a definite change in its rotatory power at room temperature (25-30° C.) under conditions even when no change in pH and colour, nor, any formation of precipitate due to adrenochrome[15,16] has taken place. On ascertaining the strength of adrenaline in the solution by the Folin method no loss is being noticed whereas on assaying the same by the usual biological process on SPINAL cat, the solution is found to be much less potent in pressor activity. A similar phenomenon is being noticed with solutions from adrenaline salts of *d*-tartaric, *dl*-tartaric, *d*-camphoric, cinnamic and coumarin 3-carboxylic acids. In cases where, however, a solution has been obtained by dissolving adrenaline in presence of Lævo-acid, such as L-malic, L-mandelic, L-camphoric and L-valeric acids, no such loss in pressor activity was noticed. The solution remains stable in other respects.

The solution would be much more stable particularly when prepared in presence of carbon-dioxide and stored in dark place.

The work is based on a pending patent application.

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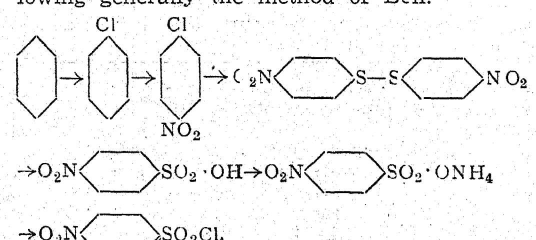
Bengal Immunity Research Lab.,
Calcutta, India,
1944.

1. Rowlinson, and Underhill, Quart. *J. Pharm. Pharmacol.*, 1939, **12**, 392. 2. Bose, Dutt and Mukherji, *Curr. Sci.*, 1942, **11**, 435. 3. Sjögren and Larsson, *Farm. Revy.*, 1936, **35**, 309. 4. Louis Julien, *J. Pharm. Chem*, 1935, **22**, 53. 5. Heard and Welch, *Biochem. Jour.*, 1935, **29**, 998. 6. Donatelli, *Chem. Abs.*, 1940, **34**, 588. 7. Welch, *Amer. J. Physiol.*, 1934, **108**, 360. 8. Nordmark-Werke, *D.R.P.*, 646561. 9. Sakuo Nomura, *Chem. Abs.*, 1938, **32**, 657. 10. Burns and Secker, *Jour., Physiol.*, 1936 **88**, 21. 11. Gunn and Harrison, *Pharm. Jour.*, 1908, **26**, 513. 12. Richard and Malmy, *J. Pharm. Chem.*, 1921, **23**, 209. 13. Debucquet, *Ibid.*, 1922, **25**, 136. 14. *B. P.*, 440968. 15. Richter and Blaschko, *Jour. Chem. Soc.*, 1937, 601. 16. Burgel and Morrison, *Ibid.* 1943, 48. 17. Woolfe, *Quart. J. Pharm. Pharmacol.*, 1941, **14**, 234. 18. Lühr and Rietschal, *Pharm. Zentralh.*, 1938, **79**, 193; *Quart. J. Pharm. Pharmacol.*, 1938, **11**, 788. 19. Haddock, *Ibid.*, 1933, **6**, 496.

SYNTHESIS OF SOME N-SUBSTITUTED *p*-NITROBENZENESULPHONAMIDES[1]

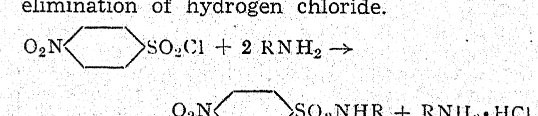
Nuclear disubstituted benzene compounds containing either a nitro or sulphonic acid group as one of the substituents, with the second substituent in the *p*-position, form an interesting group of related compounds from the standpoint of the Crum-Brown-Gibson Rule for aromatic substitution. It is well-known that the nitro group in nitrobenzene offers considerable steric hindrance to the introduction of a second substituent in the ring, especially in the case of the second substituent being an ortho-para directing group, the position taken by the second substituent being, of course, meta to the nitro group. The same remarks apply generally to the introduction of a second substituent in a compound like benzenesulphonamide.

The preparation, therefore, of a derivative like *p*-nitrobenzenesulphonamide, is of unusual interest as both the substituent groups are in mutually incompatible positions from the view-point of the rule quoted above. Hence, it is not surprising that the following indirect procedure has been adopted by workers in the field[2-8] to obtain the apparently simple compound, *p*-nitrobenzenesulphochloride. This being a fundamental reagent in this work, it was prepared in good quantity, following generally the method of Bell.[5]

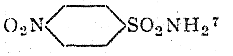
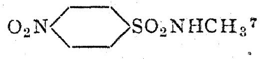
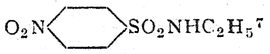
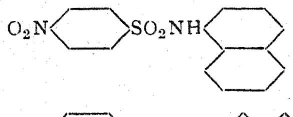
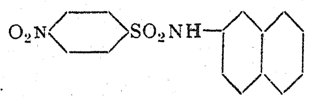
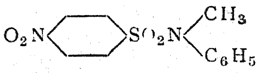
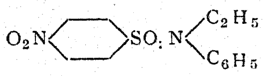
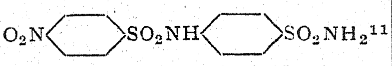


The present paper deals with the synthesis of eight N-substituted *p*-nitrobenzenesulphonamides, outlined in the table given below. Of these the last five have been reported for the first time.

The general method adopted for their preparation was the condensation of *p*-nitrobenzenesulphochloride in aqueous alcoholic solution with two molecular proportions of the appropriate amine in the cold, avoiding thereby any extraneous condensing agent for the elimination of hydrogen chloride.



The various amines as well as the whole series of intermediate products required for

Condensation of *p*-Nitrobenzenesulphochloride with	Product obtained	Yield %	M. P. in °C.	Percentage of Nitrogen	
				Calcd.	Found
Ammonia ..		93	176	..	..
Methylamine ..		86	107–107·5	..	..
Ethylamine ..		92	103	..	..
α-Naphthylamine ..		84	196–197	8·53	8·27
β-Naphthylamine ..		95	173–174	8·53	8·38
Methylaniline ..		97	127–128	9·59	9·47
Ethylaniline ..		80	158	9·15	9·11
Sulphanilamide ..		81	215	11·76	11·30

the preparation of *p*-nitrobenzenesulphochloride starting from benzene, were specially prepared and purified for this work by the usual or improved methods.

The nitrogen content of the compounds prepared was estimated by the Kjeldahl method using the modifications of Jodlbauer[9] and Cope.[10].

The specific purpose for which the above nitro compounds were synthesised was to reduce them to the corresponding azo-bis compounds which will form the subject of the next communication in this series.

My thanks are due to Mr. P. Ramaswami Ayyar for valuable suggestions and guidance, and to Dr. P. C. Guha for kind interest.

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Bangalore, (MISS) R. J. IRANI.
April 6, 1945.

1. This paper forms Part II of the author's M.Sc. Thesis entitled "Studies in the Synthesis of some substituted Benzenesulphonamides", recently submitted to the University of Madras. Part I has been published in *Curr. Sci.*, 1945, **14**, 46–47. 2. Blanksma, *Rec. trav. chim.*, 1900, **19**, 111. 3. —, *Ibid.*. 1901, **20**, 128. 4. Obermiller, *J. Prakt. Chem.*, 1914, **89**, 84. 5. Bell, *J. C. S.*, 1928, 2776. 6 Elgersma, *Rec. Trav. Chim*, 1929, **48**, 753. 7. Demeny., *Ibid.*, 1929, **48**, 1146. 8. Barber, *J. C. S.*, 1943, 102. 9. Jodlbauer, *J. C. S.*, Abstracts, 1886, 834. 10 Cope, *J. Ind. Eng. Chem.*, 1916, **8**, 592. 11. I. G. Farbenindustrie, *A.-G. Brit. P.*, 1939, 500, 118.

PRELIMINARY NOTE ON THE POSSIBLE USE OF PENICILLIN TO REDUCE THE NUMBER OF BACTERIA IN FRESHLY PREPARED COW-POX VACCINE (AGAINST SMALL-POX)

IT is a notoriously difficult task to reduce to a minimum the associated Bacteria (the chiefly occurring ones are fungus, staphilococci and streptococci—in some cases) in the vaccines prepared against small-pox from female buffalo calves—the animal that is now usually used in laboratories for preparing small-pox vaccine lymph. The usual method adopted for sterilising vaccine lymph is to suspend the finely powdered material obtained from the animals, in glycerine and store such glycerine-suspended lymph in ice box between 5° C. and 8° C., for long periods of time (8 months to a year). Bacterial counts are taken at various intervals and when the staphylococci are reduced to a minimum—by the slow antiseptic action of glycerine—the vaccine is issued for general use.

It was thought possible to use Penicillin along with glycerine, to reduce these associated bacteria to a minimum in a short time. A Flemming culture was obtained, one each, from Mr. M. J. Narasimhan, Director of Agriculture, and Dr. Ananthaswamy, Bacteriologist, Public Health Institute, for this purpose. Preliminary experiments show a very good inhibitory—*lethal*—action by Penicillin, in glyce-

rine-suspended lymph against the staphylococci which are greatly reduced in number within 72 hours. Crude non-concentrated watery extracts of Penicillin have been used for the purpose.

It is hoped soon to publish detailed reports of experiments on the use of Penicillin for sterilising cow-pox lymph so as to shorten the time of storage.

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May 2, 1945.
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Post-script.—After the above note was written, it was noticed in the letter to the Editor of the *Journal of the American Medical Association*, from Brazil, wherein it is stated that Dr. C. Miranda, of the Oswaldo Cruz Institute, Rio De Janerio, has been experimenting with Penicillin on the same lines, *i.e.*, to sterilise cow-pox vaccine by Penicillin, so as to make cow-pox vaccine available for general use within a few weeks, instead of a year or longer, as obtains now.

Journal of the American Medical Association, Feb. 24, 1945, **127**, 476.

TETANISATION OF THE HEART

IT is generally believed that heart muscle cannot be tetanised. We have come across frogs, the hearts of which resembled striated and unstriated muscle, in that they were thrown into a complete tetanus by frequent stimulation with induction shocks (Fig. 1). The results obtained were similar to those in striated muscle, incomplete tetanus passing into tetanus.

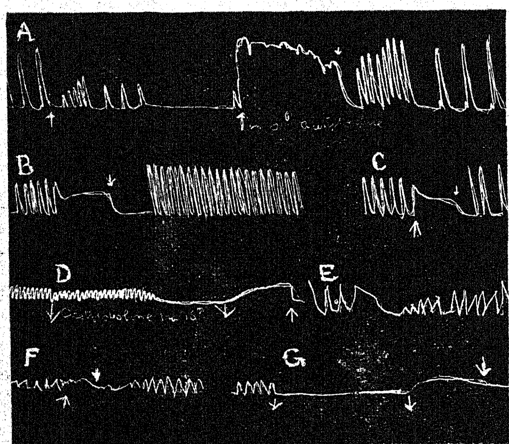

FIG. 1. *A*. Frog heart. Acetylcholine 1 in 10^9 added at first arrow. Stmulated with induction shocks from 2nd to 3rd arrow. Note the tetanus. After stimulation, the heart may be at standstill or hyperirritable. *B*. Frog heart. Note complete tetanus. After effects same as in IA. *C*. Frog heart same as IB. *D*. Effect of acetylcholine. Complete tetanus on stimulation. *E*. Same as IB. C. *F*. Frog heart, incomplete tetanus. *G*. Same heart as in F; addition of acetylcholine at first arrow. Subsequent stimulation with induction shocks. Note acetylcholine converts incomplete into complete tetanus.

Doubling the concentration of calcium in the Ringer solution prevented the tetanus, the heart responding by frequent beats instead (Fig. 2). This effect of calcium in preventing tetanus resembles that found in plain muscle (Singh, 1938). Acetylcholine had a normal effect. When the heart was brought to a complete stand still by the drug (1 in 10), stimulation with repeated induction shocks produced tetanus.

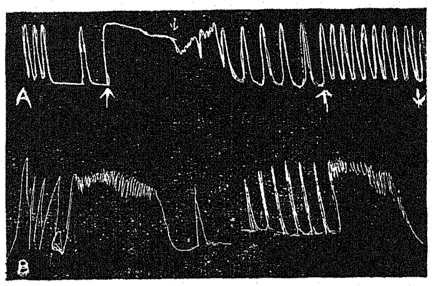

FIG. 2. Frog heart. Effect of calcium (twice normal) on tetanus. *A*. Complete tetanus. On cessation of stimulation at the 2nd arrow, the heart is still contracted. The solution now contains double the calcium content. Stimulation between 3rd and 4th arrow shows no tetanus; the heart is slightly contracted, and rate increased. *B*. Frog heart, tetanus. With adaptation the tetanus becomes more incomplete, as happens in the plain muscle. The 2nd figure shows the effect of doubling the concentration, same as in IIA. This suggests that as in the plain muscle, adaptation is due to liberation of calcium.

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Hyderabad (Sind),
January 26, 1945.

1. Singh, I., *J. Physiol.*, 1938, **94**, 322.

BLOOD GROUPS AMONG THE MAKRANIS OF WESTERN KHANDESH

THE bloods of 108 Makranis ages varying from 5 to 40, all of whom were born in their present domicile, were tested by the 'tube method'. The testing sera were supplied by the Haffkine Institute, Bombay, through the Gujarat Research Society. A few cases in which doubtful reaction (W or ?) occurred were retested against anti-A serum of known titre with capacity to react with known A, B cells, made in Lucknow. The following was the result of the grouping tests.

The Makranis belong to the same racial stock as the Baluchis and a comparison of the blood groups' incidence among them with that of the Baluchis may be of interest. According to the blood group data collected from 74 Baluchis of Baluchistan by Malone and Lahiri (1927),[1] there are 47·2 per cent. O, 24·3 per

Name of group	Total number typed	Blood group percentages				Frequencies of genes		
		O	A	B	AB	r	p	q
Makrani Moslems ..	108	37·03 (40·n)	25·92 (28·n)	24·07 (26·n)	12·96 (14·n)	·632	·192	170

cent. A, 24·3 per cent. B, and 4·2 per cent. AB. It appears that the immigrant Baluchis of Akkalkua, *i.e.*, the Makranis, have less O, similar A and B, and 9 per cent. more AB. In other words, there is a significant increase of AB at the expense of O. The total B + AB among the Baluch (Malone and Lahiri) is 28·5, while that among the Makranis is 37·03.

The Bhil blood groups are as follows:—

	O	A	B	AB
Panchmahal Bhils[2] (N·369: Majumdar)	37·0	27·5	26·5	9·0
Rajpipla Bhils[3] (N·136: Majumdar)	38·4	24·3	28·8	8·5

There is 35·5 per cent. B + AB among the Panchmahal Bhils and 37·3 per cent. among the Rajpipla Bhils showing close approximation to the Makrani data.

We found a very high incidence of AB (18·4 per cent.) among the Tharus of Tarai, who live in an unhealthy tract rife with malaria.[4] The high incidence of AB among the Makranis living in similar malarious areas, may tell us something more than appears on the surface. Wherever we find the conditions of life hard, the toll of diseases considerable, or large-scale intermixture, the percentage of B and AB is higher than in groups otherwise situated. Has tropical conditions any selective effect on blood group distribution?

Lucknow University, D. N. MAJUMDAR.
March 12, 1945.

1. Malone, R. H., and Lahiri, M. N., "The distribution of the blood groups in certain races and castes in India," *Ind. J. Med. Res.*, 1929, **25.** 2. Majumdar, D. N., "The Blood Groups of the Bhils of Gujarat," *Curr. Sci.*, 1942, 9. 3. —, "Racial Affiliation of the Bhils of Gujarat," *J. Guj. Res. Soc.*, **6,** 4, Oct. 1944. 4. —, "The Tharus and their Blood Groups," *J. Roy. As. Soc. Bengal*, *Science*, 1942. Also *Nature*, September, 1944.

TAMARIND SEED 'PECTIN'

TAMARIND seed has been desecribed as a rich source of pectin, the de-husked kernel providing nearly 60 per cent. of it.[1] A re-examination of this constituent has, however, revealed interesting differences from other pectic substances of which the chief sources hitherto have been the waste cider and citrus residues. The latter consist essentially of methoxylated galacturonic acid units, with varying amounts of arabinose and galactose, presumably derived from associated araban and galactan, loosely attached.[2] Another defining characteristic of these pectins is the formation, through de-esterification, of pectic acid, a product of definite chemical composition[3] which is obtained either directly or, better, through the insoluble calcium salt[4] after hydrolysis by mild alkali followed by neutralisation with acid. In all these respects, the alcohol-insoluble fraction from the water extract of the tamarind seed meal behaves differently and is probably, therefore, not a pectin as ordinarily understood. Thus, it is free from methyl ester groups and reducing sugars. It does not give the Carre and Hayne reaction[5] characteristic of pectins although calcium and copper salts are precipitated in alkaline medium. Nor is galacturonic acid formed on hydrolysis with acids.[6]

Perhaps the most significant difference lies in the observation that the preparation, obtained according to the procedure outlined by Ghose and Krishna,[1] is invariably associated with about 15 per cent. of albuminoides, accounting for nearly half the total proteins of the seed. The proteins are not removed or even appreciably reduced on repeated dissolution in water and re-precipitation with alcohol while mild acid hydrolysis results in simultaneous degradaton, to varying degrees, of both the protein and polysaccharide constituents. The latter are also thrown out together from solution by protein precipitants such as phosphotungstic acid and tannic acid while excessive dilution with water followed preferably by overnight's standing results in the precipitation of the proteins only, an addition of six hundred volumes of water yielding a product with less than 2 per cent. of albuminoids. Prolonged digestion with proteolytic enzymes like pepsin and papain also removes most of the nitrogenous fraction.

In spite of these differences, the preparation from tamarind seed meal sets, like pectins, to a gel with the appropriate quantities of sugar and acid. Such jellies could also be obtained from the whole seed meal due obviously to the high content of its gel-setting constituent. But, quite unlike the pectins, this gelation is not hampered by hydrolysis with dilute alkalies. Again, as with low-methoxyl pectins, commonly referred to as pectinic acids or "pectin LM", gels, though somewhat pasty in consistency, are also formed in presence of low concentrations of sugar and metallic ions such as calcium[7] while, as observed by Ghose and Krishna,[1] a thick gum is formed on reaction with borax in aqueous solution.

With pectins, several workers have attempted to relate gel-forming capacity to some one factor—like degree of esterification[8] or equivalent weight.[9] The absence of methyl ester groups in tamarind seed preparation as also other recent evidence[7, 10] would, however, suggest that there is possibly little correlation between jelly strength and methoxyl content.

Pectins have the peculiarity of possessing a variable equivalent weight or degree of acidity depending upon their extent of esterification.[9] Tamarind seed meal preparation contains 20 milli-equivalents per cent. of free carboxyl groups. Whether these or the presence in it of albuminoids have any relation to its gel-setting property are being investigated as also its chemical composition through a study of its hydrolysis and oxidation products.

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March 14, 1945.

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G. R. SAVUR.
A. SREENIVASAN.

1 Ghose and Krishna, *Jour. Ind. Chem. Soc*, *Ind. and News Edn.*, 1942, **5**, 114. 2. Ehrlich, summarized in *Abderhalden's Handb. biol. Arbeitsmcth. Abt. XI*, 1503, 1936; Schneider and Fritschi, *Ber.*, 1936, **69B**, 2537; Hirst and Jones, *Jour. Chem. Soc.*, 1939, 452, 454. 3. Nanji, Paton and Ling, *Jour. Soc. Chem. Ind.*, 1925, **44**, 253T. 4. Schryver and Haynes, *Biochem. Jour.*, 1916, **10**, 539 ; Tutin, *Biochem. Jour.*, 1922, **16**, 704. 5. Carre and Haynes, *Ibid.*, 1922, **16**, 60. 6. Link and Dickson, *Jour. Biol. Chem.*, 1930, **86**, 491. 7. McCready, Owens and Maclay, *Food Industries*, 1944, **16**, 794, 906; also *Ind. Eng. Chem.*, 1944, **36**, 936. 8. Buston and Nanji, *Biochem. Jour.*, 1932, **26**, 2090. Hinton, *Dept. Sci. and Ind. Res. (Brit.) Food Investgns.*, *Special Reports*, No. **48**, 1939. 9. Hinton, *Biochem. Jour.*, 1940, **34**, 1211. 10. Bennison and Norris, *Ibid.*, 1939, **33**, 1443.

USE OF EVERS' MODIFIED BELLIER'S TEST FOR DETECTION OF ADULTERATION OF SESAME OIL WITH NIGER-SEED OIL (*Khursani, Kala-til, Surguja*)

IN the course of our investigation regarding the detection of adulteration of sesame oil with various inferior edible oils in this city, we are generally confronted with admixture of sesame oil either with groundnut oil or niger-seed oil. This led us to apply successfully the Evers' modified Bellier's Test to ascertain proportion of groundnut oil adulteration in sesame oil. The same test is applied for the detection of niger-seed oil in sesame oil. The range between the turbidity temperatures of sesame oil and niger-seed oil is, however, small. The following are the results of turbidity temperatures and refractive indices at 40 C (Z.B.), corresponding to the different percentages of niger-seed oil present in sesame oil.

Approximate percentage of niger-seed oil present corresponding to temperatures of turbidity

Oil	Turbidity Temparature	Refr. Index at 40 C (Z, B)
Sesame ..	15—16	59·5—60
,, + Nigerseed—Oil 25% ..	18	60·5
,, + ,, 50% ..	19·5	61·0
,, + ,, 75% ..	21	62·0
Niger-seed Oil ..	22·5	63·0

This test supplemented with refractive index enables the analyst to ascertain whether sesame oil is adulterated with groundnut oil or niger-seed oil and also to ascertain the proportion of the adulterant, because the refractive index of groundnut oil is lower (55·5) than that of sesame oil, while refractive index of niger-seed oil is higher than that of sesame oil. Even if admixture of sesame oil with groundnut and niger-seed oils has been so manipulated that it indicates the refractive index of pure sesame oil, the turbidity temperature of such a product will be much higher than that of pure sesame oil. Thus this test is very convenient and useful for routine analysis. In this part of the Province, niger-seed oil is frequently used for adulterating sesame oil, because the former is much cheaper than the laltter.

Surat Borough Municipality,
Surat,
February 28, 1945.

C. M. DESAI.
A. H. PATEL.

THE UTILISATION OF SURPLUS RIVER WATER DURING THE MONSOON IN CROP PRODUCTION

DURING the monsoon Indian rivers run usually at flood levels, but owing to the maldistribution of rainfall many unirrigated areas frequently suffer extensive crop failure of the *kharif* (summer crops, such as rice, cotton, millets, pulses, maize, etc.) as well as of the *rabi* (winter crops, such as wheat, barley, gram, etc.) The cultivated area dependent on rainfall or *barani* conditions is about 161·18 million acres and is generally estimated to be about four-fifths of the total cultivated area of 208·72 million acres in India. In the unirrigated areas successful *rabi* crops such as wheat, barley, gram and other winter pulses as well as some oil-seeds depend on (*a*) adequate depth of moisture in the soil resulting from monsoon precipitation and (*b*) adequate moisture near the soil surface for seed germination at sowing time in late October or somewhat later. The failure of the winter crop in unirrigated areas may, therefore, arise from a failure of (*a*) or (*b*) or from both these causes. Failure of (*b*) means that the area cannot be sown, which means that the following winter rains will be wasted, as there will be no crop standing to utilize them. Experiments at Karnal and Delhi show that these failures can be prevented by the use of surplus river

Average yields of crops in maunds per acre (1 maund = 82 lbs.)

		Karnal			New Delhi		
		1941–42	1942–43	1943–44	1941–42	1942–43	1943–44
Wheat	Flooded ..	14·88	19·91	17·12	..	9·02	5·07
	Rainfed ..	5·45	17·41	9·92	..	9·20	2·75
Barley	Flooded ..	17·39	17·52	34·66	..	26·21	9·84
	Rainfed ..	9·94	16·60	16·52	..	22·83	12·07
Gram	Flooded ..	15·94	17·50	16·88	7·50	10·76	7·34
	Rainfed ..	0·97	14·71	13·40	3·32	10·45	3·22

water which now runs to waste in the sea. By flooding the land once only in early September, when plenty of surplus water is available, and without any further irrigations, the yields obtained during the last three years have been given in the above table.

The differences in yields are apparent in 1941-42 and 1943-44, but in 1942-43, a year of heavy monsoon rainfall (32·7 inches at Karnal and 26·9 inches at New Delhi), the differences are, as may be expected, of a lower order.

Growth of deep-rooted grasses in the grazing areas can be assured in years of deficient rainfall by the use of the surplus water which is now wasted. Canalization of the areas to use this water coupled with measures to conserve rainfall would assure the *kharif* crop completely and would result in the stabilization of *rabi* crop production on a higher level in these precarious areas.

Imperial Agricultural Research
Institute, New Delhi, C. H. PARR.
April 22, 1945.

PREVENTION OF DAMAGE TO STORED POTATOES BY THE POTATO TUBER MOTH

IN *Current Science*,[1] Rahman publlished some resutls of his experments on the storage of potatoes and damage by the tuber moth, *Gnorimoschema operculella* Zell. In view of the seriousness of the tuber moth problem nearly all over India, the problem has been re-examined.

The results given by Rahman show:—

(1) marked difference in moth damage between covered and uncovered potatoes;
(2) little significant difference in damage covered by the seven materials used, either by moth or by rot;
(3) none of the seven materials used, has any superiority, in preventing rotting;
(4) the figures for moth damage in respect of covered potatoes on the racks and on the *pucca* floor are too eratic to lead to any definite conclusion.

Rahman's statement, therefore, that the percentage of losses due to moth attack as well as rotting was higher when potatoes were stored on the floor than when they were stored on racks and that saw dust, Lantana leaves, local grass and *bhusa* gave good results, is not borne out by his data. Indeed his only finding appears to be the well-known fact that covering potatoes with some suitable material minimises moth attack.

Lefroy and Evans (1910) experimented on potato storage at Pusa; these were repeated in certain areas in the Central Provinces. They concluded that the most effective and inexpensive method of storing potato against moth attack and rotting, was to keep them covered under a layer of sand and to examine periodically, specially during the rainy season, and pick out the attacked or rotting potatoes. This method has given varying degrees of success, depending, it appears, largely on the correctness and efficiency with which the method has been practised.

Following Rahman's clue, a laboratory experiment was conducted at Cawnpore in which lots of 16 potatoes were kept covered with sand, ash, saw dust, *bhusa*, ash mixed with lime, Lantana leaves and *Murraya koenigii* leaves, together with one lot uncovered as Control and exposed equally to the tuber moth attack. The experiment lasted from 14-9-1944 to 2-3-1945. The results have shown that potatoes, covered with sand, ash and ash mixed with lime, remained completely free from moth attack while other lots suffered heavily. The percentage of moth-attacked and rotten potatoes under Lantana leaves was 91·0 and 47·9 respectively against 0·0 and 8·3 under sand and 0·0 and under ash. The experiment is being repeated on large-scale and a full account of both may be published at a later stage.

Entomologist to
the Government of U.P.,
Cawnpore, K. B. LAL.
March 28, 1945.

1. Rahman, Khan A., *Curr. Sci*., 1944, **13**, 133. 2. Lefroy, H. M., and Evans, G., *Agri. J. India*, **1910**, **5**, 19.

THE CHROMOSOME NUMBER OF *SACCHAROMYCES CEREVISIAE*

AFTER a survey of our knowledge of the cytology of yeasts Kater[1] concludes that while amitosis is of doubtful value as a process occurring during budding "the burden of proof still rests with both sides". We would like to add that an explanation should also be given as to why the chromosome number is given by Badian[2]

as two, by Sinoto and Yuasa[3] as four and by Kater[4] as probably eight. Badian is criticized (Guilliermond[5]) on the ground that his diagrammatic illustrations do not fit in with his own or Guilliermond's photomicrographs. Our uniform and consistent results[6] indicate that for the strain (S.C. 9, N.C.T.C.) investigated by us the chromosome number is two. This raises the question whether the different chromosome numbers given by various authors may not be due to studies of different races passing under the name of *S. cerevisiæ*? The numbers given by Sinoto and Yuasa and Kater are multiples of that given by Badian. Were they dealing with tetra and octoploids? If so, the results are not strictly comparable.

The previous workers must have seen what they described. Kater[1] while referring to his previous work on yeasts considers that since his success depended "to a certain extent on accident" it could not form the basis for a general acceptance of the conclusion by all workers until others manage to duplicate the results".

We have tried Bouin fixation and subsequent staining with Heidenhain's hæmatoxylin and find that the above technique reveals the two chromosomes seen in Carnoy-iron-hæmatoxylin preparations. It is not at all necessary that the cells should contain picric acid. Smears treated in the usual way would give good pictures of the chromosomes if the following precautions are taken.

(1) Use of wort cultures.
(2) Control of cultures in such a way that all cells are almost at the same phase of development.
(3) Experimental determination of the time of division.
(4) Fixation of wet smears.
(5) Long staining with iron-hæmatoxylin.
(6) Careful differentiation.

Our results suggest that the "accident" mentioned by Kater[1] is not the delicate balance between the dye and the acid but that the cells should be at some phase of the mitotic cycle. We cannot also agree with Henrici[7] that "descriptions of details in morphologic structures less than 1 μ in diameter should always be taken *cum grano salis*", since in our preparations no other structure is present in the cells to complicate the picture seen.

Why is it then, that even after filling up the "possible leak" in Kater's technique we see only two chromosomes, while Kater gives the number as possibly eight? Under the belief that Badian, Sinoto and Yuasa and Kater have been using different strains we carried out some experiments with acenaphthene. Polyploidy could be induced and on cytological examination of wort cultures after a few hours' treatment with the above chemical, one finds in every field cells with varying chromosome numbers. It appears, therefore, possible to produce a tetraploid or octoploid by controlling the time of treatment with acenaphthene. One curious fact which emerged from the preliminary experiments was the observation that the measurements of the chromosomes of the tetraploids need not agree with that of the diploids. Viewed in the light of the above discovery, it appears probable that different observers have been investigating different races passing under the name of *S. cerevisiæ*! If the above contention is substantiated, much of the genetical work on yeasts may have to be revised in the light of new facts revealed by cytology.

Our thanks are due to Mr. M. Sreenivasaya for his active interest and encouragement. One of us (M.K.S.) wishes to tender his grateful thanks to Messrs. The K. C. P., Ltd., Uyyuru, for the generous grant of a studentship.

Fermentation Technology Section,
Indian Institute of Science,
Bangalore,
February 2, 1945.
M. K. SUBRAMANIAM.
B. RANGANATHAN.

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ON THE PRESENCE OF AN OBTURATOR IN THE OVULE OF *PHYLLANTHUS NIRURI* L.

In a short note on the development of the embryo-sac of *Phylanthus niruri*, Maheshwari and Chowdry[3] (1937) reported the occurrence of a normal eight-nucleate megagametophyte when some previous workers had reported a five-nucleate one. Incidentally we also recorded the presence of an obturator in the ovule—a fairly common occurrence in Euphorbiaceæ. Recently Banerji and Dutt[2] (1944), in a work dealing with the development of the female gametophyte of *Putranjiva, Trewia, Euphorbia* and *Phyllanthus*, agree that the embryo-sac is eight-nucleate but report their failure to find an obturator either in *P. niruri* or *P. urinaria*, and suggest that Maheshwari and Chowdry probably mistook "the nucellar beak of the second ovule for an obturator". It is added that "in longitudinal sections, the nucellar beak of the second ovule sometimes gave the appearance of an obturator but close examination always revealed its true nature".

Since this is quite contrary to our observations and as the old slides on which the original study was based were no longer available for study, I sectioned some material of *P. niruri* collected from Dacca and am able to confirm our original statement that an obturator *is* clear and unmistakable. This is in agreement with the previous observations of Arnoldi[1] and others made several years ago on *Ceramanthus* (= *Phyllanthus*) (see Schnarf,[4] 1929, for literature). I am unable to offer any explanation as to why the obturator was missed by Banerji and Dutt[2] in their sections, but presume that their observations were made on non-median sections.

It may, therefore, be concluded that an obturator is present in *P. niruri* and is very

likely to be so in *P. urinaria* as well, although I have nct examined the latter species myself.

Dacca University, P. MAHESHWARI.
March 5, 1945.

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INHERITANCE OF FRUIT POSITION IN A CHILLIE CROSS

A PURE breeding strain of chillies I.P. 34, a prolific bearer with fairly pungent fruits from the Imperial Agricultural Institute, Delhi, was crossed with another pure strain, 'Yellow Wax', from Sutton & Sons, highly prized for pickles, with a view to evolve a type combining the size of the 'Yellow Wax' with the pungent and prolific bearing characters of I.P. 34. The fruits are erect in 'Yellow Wax' while being pendent in I.P. 34. The results of the crosses regarding the position of the fruits are reported below.

In the F_1 of the cross 'Yellow Wax' I.P. 34 and I.P. 34 'Yellow Wax', the fruits were found to be mostly pendant with occasional erect early stages. From each of the above crosses two-selfed F_1 plants were grown as F_2. The segregation observed was into erect and pendant fruits, with a few cases of erect-pendant fruit position, the earlier stages being erect. The last type was included among the group of erect ones, since these fruits resembled that of the 'Yellow Wax' not only in being erect in the earlier stages but also in the later assumption of a pendant position owing to an increase in size and weight. The segregation observed is given in Table I.

From the F_2 of the cross I.P. 34 and 'Yellow Wax' four-selfed phenotypes and seven-selfed ones from its reciprocal cross were grown as F_3 in the subsequent season. Segregation was observed in one family of the former and five of the latter cross. The data are given in Table II.

The only significant deviation of the expected from the observed frequencies is in family F_2-67 where the value of P exceeds 0·20.

A single factor is, therefore, involved in the expression of the fruit position.

Shaw and Abdur Rahman Khan (1928) have used position of the fruit as a diagnostic character in classifying chillies. Deshpande (1933) has shown this character to be governed by a single factor. Our observation is also in accordance with that of Deshpande. Pendant position of fruit is dominant to erect and T 34 may be designated PP for this character and 'Yellow Wax' as PP.

The cross reported above was originally made in 1940, by the Junior author, Babu R. S. Roy. We are grateful to Dr. R. H. Richharia, Economic Botanist, Bihar, for providing us with facilities for this investigation.

TABLE I

	I. P. 34 × Yellow Wax			Yellow Wax × I. P. 34		
	Pendant	Erect	Total	Pendant	Erect	Total
Observed ..	39	12	51	58	13	71
Expected ..	(3:1)38·25	12·75	51	53·25	17·75	71
	X^2 = ·059 P—0·80			X^2 = 1·695 P—0·2		

TABLE II

Yellow Wax × I. P. 34						I. P. 34 × Yellow Wax			
Family	Pendant	Exact	Total	X	P	Family	Pendant	Erect	Total
F 2—42 .	15	4	19	0·159	0·7	F 2—10	23	9	32
F 2—57 ..	19	6	25	0·013	0·9				
F 2—64 ..	5	3	8	0·67	0·8				
F 2—66 ..	22	9	31	0·269	0·7				
F 2—67 ..	18	10	28	1·7	0·2				
Total observed	79	32	111				23	9	32
Expected (3:1)	83·25	27·75	111				24	8	32
	X^2 = 0·868 P—0·5–0·3						X^2 = 0·167 P—0·5		

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Senior Scientific Assistant, Botanical Section, R. S. ROY.
Sabour,
January 9, 1945.

1. Deshpande, R. B., *Ind. Jour. Agri. Sci.*, **1933, 3**, Pt. 1. 2. Shaw, F. J. F., and Khan Abdur Rahman, "Studies in Indian Chillies," *Memoirs of Dept. of Agric. in India, Agric. Res. Inst.*, Pusa Botanical Series, **1928, 16**, No. 2. 3. Singh, M. P., *Ann. Rep. of the Bot. Sec.*, Depart. of Agric., Bihar, **1940–41**.

REVIEWS

The Measurement of Colour. By W. D. Wright. (Adam Hilger Ltd., London), 1944. Pp. vii + 223. 20*sh.* net.

A valuable addition to the literature on the science of colour has been made by the appearance of this book, written by one of the pioneer investigators in the field of colour measurement.

The science of colour is associated with the names of Goethe, Young, Helmholtz, Ostwald, Maxwell, Konig, Dieterici and Abney. These earlier workers saw the possibility of formulating a theory of colour, based on the fact that some as yet unexplained mechanism in the human eye, was able to respond to the three fundamental colour stimuli—red, green and blue, and that by the individual or simulanteous excitation of these three stimuli sensations corresponding to all the possible hues and the white, were obtained. The foundations of the trichromatic system of colour measurement were thus laid but it was not till the year 1923, that the first serious difficulties in the precise measurement of colour, were successfully overcome by Ives, Guild and Wright. The International Commission on Illumination in 1931 finally laid down the exact conditions for colour specifications by defining the illuminants A, B and C, and by specifying the colour response of the normal eye, very often spoken of as the standard I.C.I. observer.

With the essential requirements for colour measurements thus laid down on an international basis, it is now convenient to specify any colour on the trichromatic system, by a point on a rectangular chart, with only two of the trichromatic coefficients X and Y corresponding to the reddish purple and the green sensations. The third coefficient Z is given by the fundamental requirement $X + Y + Z = 1$. On such a co-ordinate system the colours of the spectrum lie on a 'hue-locus' which is in the form of a triangle. Any colour would then ordinarily correspond to a point within this triangle, the spectral blue and the red being at the left and right corners respectively, while the green is at the apex, and white at the centre.

It is obvious that such a system of colour specification requires instruments of precision whereby the three coefficients may be determined. The spectrophotometer is the earliest known and the best instrument for this purpose, but its use requires skilled manipulations. It is perhaps more practical whenever colour measurement is required to be carried out as a matter of routine, as for example, in various colour industries for their specifications, to employ, trichromatic colorimeters of the Guild or the Donaldson types. Lovibond tintometer in its most recent form serves the same purpose.

It is true that in spite of the exact specifications of colour thus made possible, secondary standards in the form of charts containing as many coloured patterns as possible would be continued to be used till a full sense of colour is generally developed and people learn to visualise the colours before them in terms of X, Y and Z coefficients. Colour atlases like The British Colour Council's dictionary of colours, containing some 200 patterns with their corresponding trichromatic coefficients and brightness factors, and the Munsell Colour charts calibrated in terms of trichromatic coefficients, largely used in America, thus form the necessary link between the ordinary and the scientific language of colour.

With the ever-increasing number of colours and their applications in various trades and industries, colour specification has assumed an importance, which was never fully recognised before. Dr. Wright has a great deal to say on all the points enumerated above and the book would greatly appeal to the student of colour physics. Intelligent layman who has anything to do with colour will also find in it portions which would lead him to a quick appreciation of the value of colour measurement. A remarkable feature of the book is the clarity of the text and its presentation.

Some of the charts and diagrams provided in the book are both original and interesting. Special mention may be made in this connection of one dealing with the location of various colours on a co-ordinate system of two of the trichromatic coefficients X and Y.

The illustration on the dust cover of the book is a little intriguing. The spectrum locus, with the position of some of the common colours indicated, and the artists pallette giving out three colours possibly the 'primaries' are well depicted. But who is the Onlooker? Does the robto-like head represent the I.C.I. observer endowed with a keen colour sense?

The book is altogether delightful and Dr. Wright may be congratulated on his success. There is no doubt it will find a place in the libraries of the educational institutions and industrial concerns which interest themselves in the teaching and application of the colour science.

B. K. VAIDYA.

Annual Review of Physiology, Vol. VI. By James Murray Luck and Victor E. Hall. (American Physiological Society and Annual Reviews, Inc., Stanford University P.O., California), 1944. Pp. viii + 630. Price $5.00.

This extremely useful, authoritative and indispensable review, as usual, contains a discussion of the progress achieved in several branches of physiology. Nineteen subjects covering the physiology of tissues and tissue-fluids, and the physiological functions and processes, are dealt with in this volume. The chapter on Development of Physiology is devoted

to a discussion of the process of development largely from the biochemical and functional points of view. Is neoplastic growth conditioned by chromosomal disturbances? What is the mechanism of the action of carcinogenic chemicals? How far do nutritional factors and harmones influence neoplastic growth? These and other interesting problems are discussed in the chapter on neoplastic growth. The physiology of the skin is the subject of an extremely interesting review by Rothman and Flesch. The rather specialised physiological functions of the skin, such as keratinisation, pigment formation and formation of long chain fatty acids and alcohols by the sebaceous glands, capillary permeability and percutaneous absorption, are specially emphasised. The bactericidal action of the ether-soluble lipoid fractions of the skin and its appendages, the ability of the skin and the follicular regions to absorb vitamins, hormones and even inorganic ions, are some of the practically significant observations which have been critically examined in this highly suggestive chapter. The review on physiological psychology presents an interesting and useful discussion of the "Three fields where the principles of physiological psychology are being developed most rapidly. These are (*a*) psychosurgery, (*b*) shock therapy, and (*c*) experimental neurosis."

Increasing importance has been given to the health of the industrial worker whose contributions to the prosecution of the war has received grateful appreciation. The efficiency of the worker depends upon his physical fitness, endurance and mental alertness. This new field of industrial physiology forms the subject of an interesting review which should be widely read. There are other equally interesting and valuable reviews, pertaining to both the fundamental and applied aspects of physiology. We have only taken a few examples at random and tried to invite attention to what has struck us at the first reading. These reviews are becoming increasingly indispensable not merely, to the wide circle of investigators in the field of physiology but also to the enlightened medical practitioner who desires to persue his profession with knowledge and understanding.

Intermediate Practical Chemistry. By P. B. Sarkar. Third Edition (revised and enlarged). (H. Chatterjee & Co., Ltd., Calcutta.) Pp. 166 + iv. Cost Rs. 1-12-0.

The long-felt need for the student of the Intermediate class (who is now mainly depending on the class notes for his guidance in the practical work) is more than satisfied by this lucid and concise book. The author has spared no pains in giving detailed instructions for many experiments described in this book. The first portion consists of eighteen preparation exercises which include the detailed instructions on the more elementary laboratory chemical practice such as maintaining the practical note book, experiments on solution, filtration, separation of the constituents of a mixture, preparation of chemicals, etc. The next section deals with inorganic qualitative analysis. The author has first given the individual tests for various basic as well as the acid radicals and then the general scheme of analysis. Unfortunately the general scheme of analysis is rather too brief to be easily understood by the student and it is hoped that this defect will be rectified in the next edition. The use of the balance and the experiments involving weighing such as determination of equivalent weights have been described next. It has to be pointed out, however, that a more elegant and accurate method must be given for the determination of the equivalent weight of zinc. A few more varieties of experiments could have been given in place of similar experiments like the determination of water of crystallisation of barium chloride, copper sulphate, etc. Amongst quantitative exercises only acidimetry and alkalimetry are given. It is very desirable to include a few more volumetric exercises like the titrations with $KMnO_4$, $K_2Cr_2O_7$, H_2O_2, etc. At one or two places (pp. 133, 148) the author suggests the pipetting out of concentrated sulphuric acid. In the opinion of the reviewer, this is a dangerous and an unnecessary habit, particularly for an Intermediate student. The last section of the book deals with some simple organic analysis like detection of carbon, hydrogen, halogens, etc., and also the determination of melting-point, boiling-point.

It is highly gratifying to note that there are very few mistakes and also that the price is quite low. It is hoped that the students of the Intermediate classes will be greatly benefited by this book on practical chemistry.

M. R. A.

Principles of Cereal Storage. By Dr. F. P. Coyne, Director of Storage, Department of Food, Government of India (November 1944).

It is curious that in a predominantly agricultural country like India, the question of combating pests and diseases of food-crops, should receive little attention in spite of the prevailing critical conditions of food shortage imposed by war. And yet, the pests and diseases of crops alone are directly responsible for the loss of crores of rupees worth of foodgrains.

Several countrywide schemes for growing more food have been launched; nowhere has the perpetual problem of protecting the very food in the process of its growth from their pests been given any serious consideration.

It is gratifying, however, that the Central Government have formed a Directorate of Storage as an adjunct to the Food Department which is entrusted with the task of properly preserving the harvested as well as imported foodgrains. One would wish that this had come into existence very much earlier and that similar directorates of "field campaign against pests and diseases" were also set up simultaneously all over India.

The handbook, *Principles of Cereal Storage*, published by the Food Department, embodies mostly the lectures delivered at a training course in the principles of grain storage, held

at the Imperial Agricultural Research Institute, New Delhi. As stated in the preface, by the author, 'this book is intended for the layman and strict scientific accuracy has been deliberately sacrificed, for the sake of clarity and brevity'.

Three main sources of loss in stored grain (loss estimated at about 3 millions of tons per annum), namely, moisture, insects and rodents, have been dealt with in an instructive manner in this book. The effect of climatic conditions on stored grains described with special reference to temperature and relative humidity, as exemplified in the case of typical inland and coastal towns like Calcutta and Bombay with a heavy monsoon and others like Karachi and Lahore with a light monsoon, is extremely revealing and acts as an eye-opener to those interested in grain storage. The close relation existing between moisture content of grains and insect development and heating and mould formation is thoroughly discussed and useful suggestions are made for minimising damage.

In dealing with insect damage to grain—qualitative and quantitative, the author has clearly pointed out the difficulties of accurately assessing damage, the fallacies of the procedure adopted by the trades people and discussed fully the correct methods of sampling and the derivation of extent of damage and loss. The standardisation of bins for bulk storage and godowns for bag-storage in India that has long been pending, has received the full attention of the author and the recommendation made, admit of ready and easy adoption almost all over the country especially at this juncture.

Of the different control measures against the insects affecting grains in storage, discussed in the book, fumigation stands out prominently. The author feels most confident in recommending widely the use of ethylene dichloride/carbon tetrachloride mixture for fumigating infested stocks.

It is hinted that the two new insecticides, "D.D.T." and "666"', expected in course of time, to be released for civilian use, would probably very effectively replace most fumigants in the treatment of premises and infested stocks. Because of the promise offered by these new synthetic products, the use of "Inert Dusts", in the opinion of the author, has but limited scope. Heat treatment of infested grains, while being effective on a small-scale, would offer obvious difficulties in large-scale work, one of them being, the proper control of temperature and avoiding damage to grain. The author also feels that no heating plant could be economically worked under the present conditions in India.

Rodent activity and damage to grain form a very important aspect of proper storage of foodgrains and the loss attributable to this agency alone might easily be a million tons of foodgrains. The problem of control has been very difficult all along. The measures suggested by the author in the work of eradication of the pest, deserve the serious attention, not only of all those concerned in the storage and distribution of foodgrains, but also of the public health authorities in this country.

The Royal Society (1660–1940)—A History of Its Administration under Its Charters. By Sir Henry Lyons. (Cambridge University Press), 1944. Pp. 334. Price 25*sh*.

This uncommon book was produced in uncommon circumstances. During June 1940 the gallant and lamented author, crippled with arthritis and approaching 76, began a fair draft, narrowly escaping death when his house was wrecked in that September. Bombed out of two hotels, he occupied five temporary homes far from libraries, reading the final proofs at Great Missenden where he died on 10th August 1944 just before publication, so closing an epic of the home front.

It may be said that when Francis Bacon (1561-1626) wrote, "Those, therefore, who determine not to conjecture and guess, but to find out and know; not to invent fables and romances of worlds but to look into and dissect the nature of this real world, must consult only things themselves", he opened the gateway of experimental science, besides giving largely unheeded good advice to slogan-ridden posterity. Soon after his death, there began to meet in London disciples interested in the new philosophy, and this Invisible College—Robert Boyle's name for the Philosophers' Society—owed immunity from religious persecution to its largely roundhead membership; later gaining protection through royal support when Charles II granted, in 1662, its first charter to the Royal Society of London for improving natural knowledge. This fortunate association is attributable to the first president, Lord Brouncker, and Sir Robert Moray, both being in favour at Court. It was no mere formality, because Pepys records that the alert-minded monarch "mightily laughed at Gresham College for spending time only in weighing of ayre and doing nothing else since they sat". This incident illustrates one of the infant society's growing pains, namely, public ridicule of the Fellows' labours, which were satirised by Steele, Addison, Swift, and more gently Pope.

Another sterner obstacle to progress was the preponderance of members who were not primarily interested in the new knowledge. The anniversary meeting of 1663 registered 131 Fellows comprising 18 noblemen, 22 baronets and knights, 47 esquires, 32 doctors, 2 bachelors of divinity, 2 masters of arts and 8 foreigners, of whom only one-third may be deemed scientific. The more decorative contingent had been elected in the unfulfilled expectation of providing monetary support, because seventeenth century enthusiasm for experiments appears to have been coupled with reluctance to pay the weekly shilling subscription. Two centuries were to pass before this obstacle was completely surmounted.

Immediately on receiving its charter the Society appointed as Curator Robert Hooke (1635-1703), Boyle's Assistant, "to furnish the Society every day they mett with three or four considerable experiments, expecting no recompense till the Society gett a stock enabling them to give it." He rendered most valuable service during forty years, first as demonstra-

tor and curator, then as Fellow-Councillor and Secretary; but seems to have shared with the porcupine its outstanding characteristic, and probably thereby postponed election of Sir Isaac Newton (1642-1727) to the presidency, which took place later in the year of Hooke's death and lasted twenty-four years. This period marks a turning point from decline and hardship, the Society acquiring (1710-80) its own home in Crane Court and beginning to make real progress continued under Sir Hans Sloane (1660-1753) who, following Newton, served the Society in various capacities during 63 years. Sir Joseph Banks (1743-1820), wealthy landowner and ardent naturalist, was president from 1778 to 1820, generously opening his London home to all men of learning and to travellers of note, while picturesquely presiding at the scientific meetings in court dress with decorations. The fellowship increased from 450 to 640, but the 2 : 1 proportion of non-scientific members persisted, while the president's wide and varied interests appear to have prevented him from giving an attention to the Society's finance and administration comparable with the precise conduct of his own affairs.

From 1821 a marked change is noticeable, coinciding with the accession of Sir Humphry Davy (1778-1829) to the presidency. By 1860 the reformers had completely amended the Society, and the scientific Fellows at last were more numerous than their colleagues who are now limited to those elected under statute 12. Among 467 Fellows at the close of 1944 the latter number 10, with 50 foreign members. Thus the Council is composed solely of scientific men who select twenty new Fellows each year, while "persons who have either rendered conspicuous service to the cause of science or are such that their election would be of signal benefit to the Society" may be selected on an annual average of one (Statute 12). Financially too, the Society had long ago reached smooth water, securities in the general purposes found amounting in 1833 to £14,000 and growing to £155,000 at the close of 1944: the aggregate of special funds, research funds and Warren research fund whose capital must be kept intact, greatly surpasses this amount.

Thus throughout its eventful growth, Sir Henry Lyons has traced administration of the Royal Society in painsgiving detail. Elected a Fellow in 1906, serving as Councillor, foreign secretary, vice-president and for ten years most ably and with great zeal as treasurer, he leaves a sterling monument to the venerable body he loved so well and served so well, with unfailing good humour and rare modesty.

M. O. F.

SCIENCE NOTES AND NEWS

During the course of a lecture on 31st March under the auspices of the Society of Biological Chemists, Bangalore, Sir J. C. Ghosh vividly described the changes that have come about in California during the last seventy years. The present prosperity of California was due not only to gold and oil but also to the vast irrigation scheme which supplies the necessary water for agricultural purposes. He pointed out how it has been possible for Californian fruit to be sold on the Calcutta market cheaper than fruit from the Punjab.

While describing the Tennesse Valley scheme, he pointed out how the project has stopped soil erosion in the area and how the use of phosphates manufactured in the tract itself from raw materials found locally and from power generated on the spot has made the lands fertile by its application to grow leguminous crops thereby enriching the soil with nitrogen also. He laid great emphasis on the prevention of wastage of irrigation water by stopping seepage from irrigation channels, on the measures taken to keep the tract free from malaria and on the measures adopted to facilitate traffic by promoting navigation as well.

All this has been done by adopting a long-range policy and by spending millions of dollars in the interests of the country without looking to an adequate immediate financial return. It was pointed out that a financial return of even 3 per cent. was considered satisfactory.

In our own country of India, many a big irrigation scheme has been put through in recent years and further schemes are under consideration. While people in America talk in millions of dollars our administrators very often hesitate to talk even in lakhs of rupees. While a return of 3 per cent. is considered satisfactory in that country, a guarantee of at least 6 per cent. is expected here. Measures to prevent the advent of malaria in an irrigation tract are rarely thought of and put into execution simultaneously with starting of irrigation. Furthermore, measures to prevent formation and rise of alkali in an irrigated tract thereby preventing soil deterioration are rarely thought of except after the problem has become very acute and land has begun to go out of cultivation.

Sir J. C. Ghosh laid great stress on the measures taken to prevent wastage of water in that country by making the irrigation channels quite water-tight to prevent seepage and percolation. He emphasised the great wastage of water in this country due to the nature of irrigation channels. While measures are being taken to form tarred and cement roads on a very large scale in the near future, we do not hear of any adequate measures to make our irrigation channels water-tight to avoid loss by percolation and seepage. Our people seem to be quite satisfied with a spectacular sight of a huge reservoir full of water without devoting much thought to the economic use of such water stored at great expense.

Just like the Tennesse Valley soils, our Indian soils too seem to be very much in need of phosphatic manures to build up soil fertility

and ensure big yields per acre. A suitable irrigation policy to enable the cultivator to grow leguminous crops by liberal phosphatic manuring and thereby enriching the soil with the much-needed nitrogen also is urgently called for.

If irrigated areas are kept free from malaria, measures are taken to prevent formation of alkali in the soil wherever necessary, and a suitable irrigation policy devised to make it easy to grow green manure crops it seems quite possible to double the yield from our lands already under cultivation in about 20 to 30 years. In that case, this country will be able to provide food for more than 500 million people.

While winding up the proceedings, Dr. Fowler, the Vice-President of the Association, laid stress that provided men and materials are available for work, money will be forthcoming by itself. I respectfully beg to differ from the above statement. While there are enough qualified men to undertake such work in this country, financing an agricultural scheme with a long-range policy seems to be rather difficult. The industrialist who always looks to an immediate big return is not interested in it and Government does not seem to be very keen on a long-range policy without the guarantee of an adequate return.

Our only hope lies in the many post-war development schemes that are now being forged and we trust that they do not get shelved with the return of normal conditions.

B. N. I.

In view of the importance of tobacco as a valuable commercial crop and the variety and complexity of problems relating to its production, processing and marketing, the Government of India have decided to set up an Indian Central Tobacco Committee on the lines of similar other Commodity Committees for Jute, Cotton, etc. The functions of the Committee will be to assist in the improvement and development of the production and marketing of tobacco and all matters incidental thereto. The Committee will devote its special attention to the improvement of the flavour and aroma of Indian tobacco, and research on these problems will be taken up shortly. The Government of India will finance the Committee by placing an annual grant of Rs. 10 lakhs at its disposal.

The Government of India have decided to expand the facilities for post-graduate training, and to admit fifty students a year from April 1945 onward at the Imperial Agricultural Research Institute, with a view to meeting the growing demand for the training of higher agricultural staff at the Centre and in the Provinces and States.

So far the Institute admitted on the average sixteen students per year for training in five sections. There will be now two more sections, *i.e.*, Agricultural Engineering and Agricultural Economics and Statistics added to the Institute.

The total cost of the scheme for the first year would amount to Rs. 1,75,100 and will fit into the full Five Year Plan of the expansion of the Institute as a post-war measure.

Dr. Alagappa Chettiar has donated an additional contribution of two lakhs of rupees to the opening of a College of Technology in the Madras University. Dr. Lakshmanaswami Mudaliar, the Vice-Chancellor, in acknowledging the gift, referred to the munificence of the donor as the largest single contribution to the University.

The Nobel Prize for Chemistry for this year will be awarded to Dr. Chou-Hou-Fu, Dean of the Science College of the National Szechwan University, says the bulletin issued by the Chinese Ministry of Information. Dr. Chou will be the first Chinese to win the Nobel Prize.

The President, Forest Research Institute, has advised that the statement appearing in *Current Science* (March 1945, p. 84) that Sir Herbert Howard has been appointed Adviser to the Government of India on Forestry, is not correct. We deeply regret the error. We have been informed that Sir Herbert Howard has gone on leave preparatory to retirement.

SEISMOLOGICAL NOTES

Among the earthquake shocks recorded by the seismographs in the Colaba Observatory during the month of April 1945, there were eight of slight and one of moderate intensities. The details for those shocks are given in the following table:—

Date	Intensity of shock	Time of origin I.S.T.	Epicentral distance from Bombay	Remarks
		H. M.	(Miles)	
10	Slight	07 52	4460	
10	Slight	22 46	3290	
15	Moderate	09 05	5195	Epc. near Kamchatka
18	Slight	19 35	4165	
19	Slight	19 34	7245	
20	Slight	00 17	1730	
22	Slight	10 19	5190	
22	Slight	16 23	2055	
23	Slight	13 00	1555	

As we go to the Press, we have learnt with the deepest sorrow that Sir Martin Forster, formerly Director, Indian Institute of Science, Bangalore, and one of the principal founders of *Current Science*, passed away peacefully at his residence in Mysore on Wednesday, the 23rd May 1945.

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CURRENT SCIENCE

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FOOD PRESERVATION AND FOOD TECHNOLOGY

THE Department of Food of the Government of India has constituted a Technical Panel of Scientists to advise the Department on the preservation and processing of food. Addressing the first meeting of the Panel, Sir J. P. Srivastava, Food Member to the Government of India, declared:

"The problem of food has during recent years engaged the increasing attention of almost all Governments in the world. And it is right that it should be so. Food is the very bedrock of a nation's life and well-being. It is the foundation on which practically all else is built. This is a truth which has long failed to receive the amount of recognition it deserves. Researches in the field of food and nutrition during the last two or three decades have shown how urgent and important this problem is. There is an increasing realisation that between optimum health and flank ill-health there is a considerable no man's land in which people may not be suffering from any obvious disease and yet may not be enjoying that standard of health and vigour which an optimum diet could have afforded them. Even in countries like Britain and the U.S.A. where the general nutritional level is considerably higher than in this country, practically half the population has been considered to be receiving a sub-optimum diet by this standard. In his message to the Hot Springs Conference the late President Roosevelt directed attention to this vital problem and stressed the fact that agriculture and food industries of the world still employed the vast bulk of the population of the world and required far greater consideration than they had so far received. The organization of the United Nation's Interim Commission on Food and Agriculture is a development in this direction. It is fitting that this problem should also receive organized attention in this country.

"The problem of food rests principally on three pillars:

(1) The production of raw foodstuffs;
(2) the food-technological industries including the preservation, processing and fortification of foodstuffs, vitamin technology and all related problems;
(3) the distribution of food to the population according to physiological needs.

FOOD PRESERVATION

"It is with the second set of problems that you will be more specially concerned. Ours is mainly a tropical country, considerable parts of which have in addition a humid climate. These are ideal conditions for food-stuffs to undergo spoilage by insects, micro-organisms and also by normal biochemical processes. While exact figures are not available, our economic loss per year owing to the spoilage of foodstuffs of all kinds must be running into tens of crores of rupees. Ours is pre-eminently a country where food-technology should have reached a high-watermark of development. In Britain and in America, food industries are highly developed. In Britain there are institutions investigating food-technological problems, covering cereals, meat, fruits, fish, etc.; so also in America. These are in constant touch with food-industries, which are getting a higher goal for their standard of production as researches go on.

"It is clear that if countries enjoying a temperate climate, where the rate of spoilage is much less than in ours, take so much care in the preservation of their foodstuffs, our responsibility in this matter is much greater. Beginnings have been made in this country. The jolt of a war knocks off slumber. The question of prevention of spoilage of cereals is receiving much greater attention now than ever before. Canning of fruits has been started on a large scale in the North-West Frontier Province and we hope with increasing standardisation of fruits and further improvement of processing our standard will at least be equal to that of the best canned fruits of other countries. The development of the hydrogenated oil industry has received a great spurt during the war and we are at present engaged with the question of its further development on sound lines. The biscuit industry has been considerably expanded. Industries like those of pepper, mustard, golden syrup, sugar cubes, lime juice cordial, refined salt, etc., have been sought to be developed. It will be our earnest endeavour to see that these industries outlast the war. The problem of the production of vitamins and the fortifications of various foodstuffs with vitamins and minerals, as has been done in the U.K. and the

U.S.A. is before us. The question of food-yeast production from molasses is also receiving consideration.

Dehydration and Refrigeration

"The new industry of dehydration has been greatly developed as a result of the war. A considerable body of knowledge has been gathered in course of this development. It is for you and us to consider what part of this industry can be switched on to peace-time production. It is my earnest hope that the fruit dehydration industry which has started on a large scale in the N.W.F.P. may be established on sound lines and become a permanent feature of the food industry in this country. Dehydration of vegetables and fish has been carried out indigenously in village homes in various parts of the country for a long time and it is for you to consider whether, with the help of the knowledge now available about more scientific methods of dehydration, the old indigenous methods may not be improved or transferred to new lines. The food-packing industry is also an important one, to which I would like to invite your attention.

"Refrigeration is now considered to be the best method of preservation of perishable materials like fish, meat, vegetables, etc., and I would request you to consider this question also with reference to this country.

"The implications of a well-organized food industry are colossal. It is meant to (1) prevent or diminish spoilage, (2) remove foodstuffs from seasonal gluts thus preventing waste and making them available in other seasons, (3) increase or retain the nutritional value of foodstuffs, and (4) produce new foods like yeast, synthetic vitamins, vitamin concentrates, etc. Great things can and will be achieved by the application of science and technology to food. Food has even been produced from wood and during the present war, fats have been made from coal. I do hope by your joint endeavours with our technical experts, you will be able to help us in the development of a full-fledged food-industry in this country on scientific lines."

TATA MEMORIAL HOSPITAL FOR THE TREATMENT OF CANCER AND ALLIED DISEASES*

PHILANTHROPISTS are the back-bone of any enlightened community, and in India, the House of Tatas has perhaps no equal. The first triennial report of the Tata Memorial Hospital for Cancer shows what enlightened philanthropy could do for the alleviation of human suffering.

On the suggestion of Sir Frederick Sykes, the then Governor of Bombay, Sir Dorab Tata agreed early in 1932, to finance the establishment of a Radium Institute in Bombay. "As originally visualized, the scheme was on a modest scale, providing for the purchase of 400 milligrams of radium at an estimated cost of Rs. 2 lacs which included an endowment for its upkeep."

Owing to the unexpected demise of Sir Dorab Tata in 1932, the "duty of carrying through the project devolved on his Trustees". In order "to provide a worthy memorial to the spirit of enlightened philanthropy embodied in the persons of Mr. J. N. Tata and his two sons, Sir Dorab and Sir Ratan", the Trustees decided, after consultation with experts like Prof. Regaud of Paris, Dr. Patterson of Manchester and particularly Dr. Ewing of Memorial Hospital, New York, "to start a Cancer Hospital instead of a Radium Institute and equip it with the necessary adjuncts for surgery, X-rays and Radium—for, though a Radium Institute would undoubtedly supply an urgent want in Bombay, the type of service it would render would necessarily be restricted". "If its scope could be enlarged with a proportionate increase in the benefits conferred, the Trustees were of opinion that the much greater expenditure involved in building and maintaining a Cancer Hospital would be justified". Thus came into being the best institution for the treatment and study of Cancer in the East, built and equipped at a cost of Rs. 4,000,000. It was opened on the 28th February 1941 and up to date, some 7,000 patients have had the benefit of the knowledge of the experts in the staff of the institution.

Its modest achievements detailed in the report, makes one hope that after the termination of the hostilities, the extension of the teaching and research programme envisaged, would "really contribute its share to the solution of the many problems that are encountered in the study of Cancer". Realisation of this aim would be possible, only if the best brains in pure science are attracted to the laboratory and given not only facilities, but what is more important, unfettered freedom.

Cancer is a problem of the West while Leprosy is the problem of the East. Care of over five thousand Cancer patients in the course of three years is no mean record, but this pales into insignificance when it is realized that among us in India to-day, there are 1,500,000 lepers. One out of every three lepers in the world is in India. Even the erudite refuse to consider this serious leper problem, owing to the horror and loathing instilled into every one, by generations of dread of the disease. The problem has to be tackled some time, if we wish to rid India of this foul disease.

When theology is unable to fit the lepra bacilli in any Cosmic Plan, when scientists during the past five decades have failed not only to discover a remedy but even to make out whether the bacilli seen in a lesion are living or dead, when all attempts either to cultivate the bacilli or to transmit it to laboratory animals have failed, and when it is impracticable to dream of either isolating all the infectious cases or of separating from leprous parents their children at birth and rearing them up under ideal conditions by legislative measures, it is up to organized philanthropy to encourage investigations on the disease, extend to the victims, the benefits of medical science and rear up children of leprous parents free from chances of infection.

One fervently hopes that the next great philanthropic venture of the House of Tatas would be an attempt to tackle the problem of Leprosy in India.

M. K. Subramaniam.

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* "First Triennial Report," Bombay, 1945.

OBITUARY

SIR MARTIN ONSLOW FORSTER, F.R.S.

TO his wide circle of pupils, friends and admirers, both in India and abroad, the sad news of the sudden and unexpected death of Sir Martin Forster which occurred at his residence in the city of Mysore on 23rd May 1945 has come as a severe shock. He was seventy-two. A few weeks prior to his death, on 8th of May 1945, he sent for publication in *Current Science* a "connected story" of the Royal Society which has been posthumously published in the last issue of the Journal. He had informed his numerous friends in Bangalore that he had planned to stay there for a couple of weeks.

Sir Martin was born on the 8th of November 1872; he received his education at the Finsbury Technical College. His academic career was punctuated by the award of several research fellowships and scholarships; in 1894 he secured the research fellowship of the Salters Company; in 1899 he became Granville scholar at the University of London. In 1915 he was honoured by the Chemical Society by the award of the Longstaff Medal. In 1905, at the early age of thirty-three, he was elected a Fellow of the Royal Society. For about ten years (1902-13) he held the position of an Assistant Professor at the Royal College of Science, South Kensington. He served the Chemical Society as its Honorary Secretary during the period 1904-10 and was elected Vice-President, Institute of Chemistry for 1908-11.

During the last War when the British Dyestuff Industry was reorganised and consolidated, Sir Martin was invited to serve on the Directorate of the British Dyes Ltd. (1915-18). From 1918-22, he occupied the post of Director of the Salters Institute of Industrial Chemistry. He was elected President of the chemical section of the Edinburgh session (1921) of the British Association for the Advancement of Science; his presidential address to this meeting bears the imprint of his discipleship under Emil Fischer.

During one of his visits to England, Sir Dorab Tata extended a personal invitation to Sir Martin Forster to accept the Directorship of the Indian Institute of Science, Bangalore. The administration of the Institute had, for some time past, been the topic of adverse criticism both from the public and the press; a committee of enquiry, presided over by Sir William Pope, had just issued its report and published its recommendations for the future working of the Institute. The Institute, at that time, needed a gifted administrator of far-sighted vision and outstanding ability, endowed with a sympathetic understanding of the special needs of the country. Sir Martin Forster accepted the invitation of Sir Dorab and took charge of the Institute as Director on 3rd November 1922.

The reorganisation of the Institute during that critical period was an extremely delicate and difficult task. Sir Martin had to steer clear of the strongly entrenched vested interests on the one hand and on the other, a critically-minded public who were agitating for a thorough overhaul of the administration of the Institute. With characteristic skill and determination, Sir Martin set himself to the task of reforming the Council and overhauling the staff; he brought about a "miracle" in the administration and the tutorial and research activities of the Institute. He was fortunate in securing the willing and enthusiastic co-operation of his colleagues—the late Professor Catterson Smith, Professors Norris, Simonsen and Watson—a brilliant team, who, under the inspiring leadership of Sir Martin, expanded and modernised their respective departments.

Sir Martin's Directorship, which covered a little more than ten years, marks an eventful era in the history of the Institute, distinguished by scientific achievement and technological progress. New courses, *e.g.*, Communication Engineering, were inaugurated; fresh lines of research were initiated; the necessary funds and facilities were freely and abundantly made available to the scientific investigators; Sir Martin raised the prestige of the Institute,

founded an edifice of liberal traditions of the highest academic life, created an atmosphere of confidence and contentment, and inspired the young men who passed through the Institute during the period to build up the qualities of courageous leadership and professional integrity. His greatest contribution to the scientific and industrial advancement of this country is the successive generations of young men who passed through the Institute; these are now filling positions of responsibility and trust throughout the country.

Sir Martin relinquished the Directorship on 31st March 1933 and at the gracious and kind invitation of the late His Highness the Maharaja of Mysore, he settled down in the peaceful and lovely environments of the Garden City of Mysore. During the period of his retirement he placed himself at the disposal of those who sought his counsel and help. He continued to take a keen interest in the affairs of the Institute. He was invited to serve on the Council of the University of Mysore and on the Advisory panel of the Board of Scientific and Industrial Research of the Government of Mysore.

Current Science owes its inception largely to his genius and foresight; he presided over the inaugural meeting convened to consider the founding of the Journal and conducted the proceedings with great tact and deep sympathy. He was intimately and actively connected with the progress of the Journal whose pages he has enriched with his editorials, reviews and notes on important questions of the day.

Almost to the end, he kept himself active and alert; those of us who saw him a few weeks before his death could hardly have imagined that his end was so near. In his death, we have lost a sincere friend, an outstanding chemist, an inspiring teacher, a sympathetic adminstrator and a great gentleman. His pupils and colleagues will for long cherish his memory with gratitude and affection.

DR. STANLEY KEMP, F.R.S.

THE death of Dr. S. W. Kemp, Director of the Marine Biological Laboratory at Plymouth, on the 16th of May, has removed one of the foremost figures in the field of marine biological and fishery investigations in the British Commonwealth.

Kemp was born in 1882 and was educated at the St. Paul's School, and at the Trinity College, Dublin. He began his scientific career as Assistant Naturalist to the Fisheries Research Section of the Department of Agriculture and Technical Instruction, Ireland, which he joined in 1903. Investigation of the fauna of the Irish seas was one of the main problems of the Department and it was there that Kemp began his series of studies on the Crustacea, a group in which he subsequently became an outstanding authority. With the re-organization of the Indian Museum at Calcutta, he joined its zoological section in 1910 as the Superintendent. The constitution of the Zoological Survey of India which followed and the active collaboration of Kemp and the then Director, the late Dr. Annandale, was a period of great expansion of the activities of the Survey which produced the most fruitful results in the study of the Indian fauna. The development of the different sections of the Museum and of its two scientific journals, the *Records* and the *Memoirs*, owes much to the enthusiasm and energy of Kemp. His scientific work was on the taxonomy of Indian Crustacea, mainly the Decapoda, but in addition he devoted much time to the biological surveys of the Chilka Lake and of the Siju Cave in Assam, sharing the same enthusiasm and versatile qualities of his friend and chief, Annandale. During the Abor Punitive Expedition (1911-12) he was attached to the party as the Zoologist and Anthropologist. The expedition led to the discovery of Peripatus (*Typhlloperipatus williamsoni* Kemp) on the north-eastern frontier of India at the foot of the Himalayas.

Kemp's connexion with the Zoological Survey was cut short when in 1924 the Colonial Office constituted the Discovery Committee which he joined as the Director of Research and led the second Discovery Expedition to the Antarctic. After his return he was fully occupied with the co-ordination of the results of this Expedition in relation to Whale Fisheries and the editing of the series of Scientific Reports. He was elected a Fellow of the Royal Society in 1931 and he presided over the Zoological Section of the British Association in 1937.

In 1936 the late Dr. E. J. Allen after a most distinguished period of Directorship of the Plymouth Laboratory for over 42 years expressed his desire to retire and Kemp was chosen as his successor. It is in this official position that his organizing abilities and broad vision in regard to scientific development found their full expression. Extended facilities for visiting workers and the staff were provided in a new scheme of expansion which Kemp carried out in 1939 and in the summer that preceded the outbreak of the Second World War there were no fewer than forty visiting scientific workers at the Plymouth Laboratory.

The outbreak of war created many problems for continuing the work of the laboratory but the crisis came in March 1941 when much damage to both building and equipment was done by the successive air-raids on Plymouth. Kemp himself was the worst sufferer for he lost all his personal possessions and his library along with much of his unpublished work. Through those difficult months that followed he steered the Institution with great courage and determination, losing no time to have detailed plans drawn up for the reconstruction of the Laboratory as soon as times permit rebuilding. His great ambition was to develop Plymouth into a strong nucleus for fundamental research on and training in fishery problems during the post-war period.

In regard to India he maintained an active interest in the problems relating to fishery work and did much to focus attention on this important aspect of National Planning. The last few months of his life were devoted to building up a strong organization for promoting Fisheries Investigations in the different countries of the British Commonwealth. His death is a great loss to the scientific world at a time when his mature judgment and counsel would have been invaluable in the drawing up of schemes for post-war reconstruction.

N. K. PANIKKAR.

COPPER-CUPROUS OXIDE RECTIFIER

By K. R. Dixit
(Gujarat College, Ahmedabad)

Numerous "Sperrschicht Cells" or "Barrier layer" rectifiers are in commercial use; but no material appears to have been more extensively studied or utilised than the copper-cuprous oxide rectifier. These rectifiers satisfy the demands for the direct current and are used in battery-charging, in electroplating, in preparing A.C. measuring instruments, in telecommunications and as photo-electric cells. The practice has far outrun our knowledge of the fundamental nature of the problem and we are forced to follow the trial-error and inferential methods of procedure. Our present knowledge appears to indicate that the rectification is governed by statistical laws. Scientific interest has been stimulated mainly by the ever-increasing use of the effect in industry. We have undertaken to study systematically the various factors which alter the rectification of cuprous oxide layers, with a view that such a systematic knowledge will enable us to understand the mechanism of the rectifying action. This paper gives a short summary of the work we have done so far, but for the sake of giving the readers a complete picture we have included some work done by others.

In general when voltage is applied to a conductor the current which flows is independent of the direction of the voltage. But some composite conductors show asymmetric conduction, that is, the property of passing currents more freely in one direction than in the opposite direction. The direction in which more current flows is usually called the forward or the conducting direction and the other the reverse or non-conducting direction. The rectification occurs at the contact between the two dissimilar substances.

In 1926 Grondahl observed that a plate of copper upon which a thin film of cuprous oxide has been formed could be used for the rectification of currents of considerable magnitude. The rectifier was made by partially oxidizing a sheet of copper in air at about 1000° C. and then by allowing the oxidized sheet to cool to room temperature. When one electrical contact was made to the copper sheet and another to the oxide by a metal foil applied under pressure, it was found that the element passed current readily from oxide to copper but much less freely in the other direction. The process which is used to-day in preparing the cuprous oxide rectifier is similar to the Grondahl's original process.

For best effects the copper needs to be of exceptional purity, it was supposed at one time that it should be completely free from silver but later experiments have disproved this. Since it is the surface of the metal which is used in making the rectifier it is essential that it should be clean and with a perfect finish. Pure copper (to which suitable amounts of inclusions can be added) is poured in a molten state, then it is rolled (or hammered) in strips of 1 mm. thickness, from this is punched the blank to be oxidized. It is established that grain-size, hardness, etc., are of no importance. There is no test of the suitability of rectifier copper other than the preparation of rectifiers from it.

The blanks are oxidized in pure air at about 1020° C. Cupric oxide formed at lower temperatures becomes unstable at 970° C. and is reduced to cuprous oxide. The furnace temperature must not exceed 1040° C. Upto an oxidation temperature of 1020° C. the higher the temperature the lower the forward resistance of the rectifier. The temperature of the furnace is allowed to remain at 1020° C. for about 12 minutes and an oxide film of about 0·1 mm. thickness is formed. The annealing is done in two stages upto 600° C. in 15 minutes in the furnace and then it is removed and cooled to the room temperature. Some physical deformation is produced, in the oxidizing and annealing process, but if copper is oxidized on both sides the element remains flat. The cuprous oxide is in the form of a hard bright red crystalline layer adhering very firmly to the mother copper but covered by a very thin film of black cupric oxide which has been formed during annealing. The insulating film of black oxide was originally removed by mechanical means, but later a concentrated solution of sodium cyanide was employed, now this has been superseded by a mineral acid process. These changes have been accompanied by marked improvements in the magnitude of the reverse resistance. If now an efficient electrical contact is made with the cuprous oxide the rectifier element becomes ready for use. If a soft metal is simply pressed in contact with the oxide layer the contact resistance is very high; so powdered carbon is rubbed into the surface and a soft metal foil is pressed on. Or colloidal graphite in aqueous suspension is painted on the surface and is dried; contact may be made with graphite either by soft metal under pressure or by spraying, vaporising or cathode sputtering a metal electrode which gives good contact without the use of pressure.

The resistance of the rectifier either in the forward or reverse direction depends on the applied voltage, that is, the rectifier does not obey Ohm's law. The resistance varies with the applied voltage, temperature and time. The most important electrical property of a rectifier is its self-capacitance which is of the order of $0 \cdot 02 \mu$F. per cm.^{2} This value varies with the voltage and current in the rectifier but is practically independent of the frequency. The capacitance has the effect of increasing the reverse leakage when the rectifier is used at high frequencies. The electrical properties of the rectifiers can be varied considerably at the will of the manufacturer.

Cuprous oxide layer formed in this way exhibits photoconducting properties and can be used as a cell showing photovoltaic effects. In the normal cuprous oxide rectifier, when

light falls upon the oxide surface the photo-current flows from copper to oxide internally, that is, in the reverse direction, and it may be expected that the magnitude of the current would be related to the reverse characteristic of the rectifier. There is, however, no evidence to support this. The cell has a red and infra-red colour response and the cut-off at the end of the visible spectrum corresponds exactly to the commencement of the light transmission of the cuprous oxide, which, therefore, must be acting as a filter. Maximum colour response is approximately in the middle of the visible spectrum.

SPERMATELEOSIS AND NUCLEINATION

By B. R. SESHACHAR
(Department of Zoology, Central College, Bangalore)

SINCE the early studies of Miescher[1] followed by those of Steudel and Peiser[2] on the chemical constituents of the sperm-heads, it has been known that these, which represent so far as we know, the consolidated essence of nuclear matter, contain a large percentage of nucleo-proteins which make up much of the chromosomes of the nucleus. In fact, our knowledge of the chemistry of the nucleus has largely been based on these pioneer studies, and as a result, it has now been clear that the chromosomes are in the nature of complex salt-like compounds of proteins and nucleic acids called nucleo-proteins. The two conditions of the nucleus, that of rest and that of division, differ mainly in the polymerization of nucleotides on the protein framework of the chromosomes. It is surmised that most, if not all, nucleic acid of the chromosome comes from the cytoplasm where it exists as isolated nucleotides and which are transferred to the chromosomes at the beginning of every mitosis. In fact, one of the important changes associated with mitosis is the nucleination of the chromosomes, whose fixability, and visibility under the microscope are due to the accumulation of nucleotides on the protein framework of the chromosome, which is the permanent part of the chromosome, the nucleic acid varying in amount at different stages of the mitotic cycle. It has even been suggested that the sudden increase of nucleic acid in the chromosomes at pro-metaphase of mitosis is due to the breaking down of the nuclear membrane at this stage and the free transference of material from the cytoplasm to the chromosomes (White[3]). So the idea has gained ground that the mitotic process is a necessary prerequisite for the organization of the chromosomes in a recognizable form, and for their nucleination. For, at no other stage the chromosome is visible in the nucleus, nor is thymonucleic acid identifiable in the nucleus at any other time.

But that leaves the sperm-head, which has formed the important source of our information on the chemistry of the chromosome, out of the picture. The sperm-head is analogous to the metaphase chromosome in that it represents the synthesis and accumulation of the maximum amount of nucleic acid in relation with the protein; but while in the latter case, this synthesis has been achieved with reference to mitosis, in the former, the synthesis of nucleic acid has taken place without any reference to division and indeed, without any reference to the chromosomes. The sperm-head, therefore, offers the only example of the synthesis and accumulation of desoxyribose nucleic acid outside its relation with the definitive chromosome.

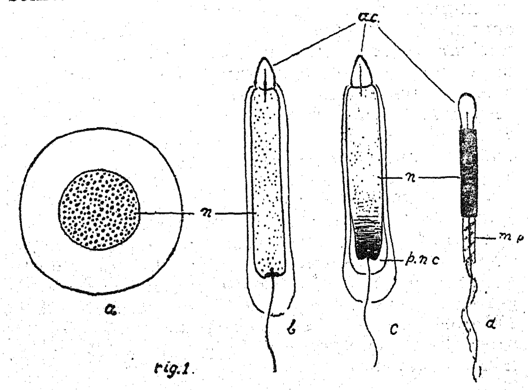


FIG. 1. Four stages in the spermateleosis in *Ichthyophis glutinosus*. × 600.

a. Resting nucleus of the spermatid.

b. Elongation of the nucleus during spermateleosis.

c. Beginning of nucleination from the posterior end.

d. Fully formed spermatozoon.

ac. acrosome; *m.p.* middle piece; *n*. nucleus; *p.n.c.* post-nuclear cavity (which later becomes the middle piece).

The process of spermateleosis confirms this. The animal spermatid has a resting nucleus, and associated with changes which vary in different animals, this nucleus begins gradually to synthesize nucleic acid within it till in the fully formed sperm, the nucleus is the packed essence of nucleo-protein. If the mitotic cycle involves the transference of cytoplasmic nucleotides into the nucleus and their conversion from ribose to desoxyribose nucleotides, then the same process must take place during spermateleosis also, where, however, without changes associated with mitosis and without the formation of organized visible chromosomes, the essentials of the same process of deposition of desoxyribose nucleic acid takes place in the nucleus.

There is yet another parallel between the development of the metaphase chromosome and that of the spermatozoon. In both it is probable that important changes occur in the

protein constituents. Miescher[1] himself showed that the metaphase chromosome, like the sperm-head, contains only simple proteins of the histone and protamine types associated with desoxyribose nucleotides, the higher globulin types of proteins breaking up during mitosis and spermateleosis respectively (Miescher,[1] Darlinghon,[4] Caspersson[5]). But this similar end result is achieved in two different ways, in one case by the organization of the chromosome with which the nucleotides are associated, and in the other, without the formation of definitive visible chromosomes.

When we talk of condensation and consolidation of the nucleus during spermateleosis, it implies much more than a mere physical change. It means primarily, a reduction in nuclear volume brought about by an expulsion of water and nuclear sap. This reduction is often considerable as shown in the Apoda (Amphibia) by the author[6] where it may be as much as 95 per cent. But it also means another more important thing. It means the acquisition of nucleotides by the consolidating nucleus from the cytoplasm if they have to come from outside the nucleus; or if they have not, their production inside the nucleus itself. In this matter, whatever the condition in embryonic and meristematic tissues where cytoplasmic ribose nucleotides have been detected (White[3]), in the developing spermatid at any rate, their occurrence in the cytoplasm in any large quantity is highly improbable. The amount of cytoplasm in a developing spermatid (of the Apoda, for instance) is so inconsiderable that the likelihood of there being any appreciable quantity of nucleotides in it to contribute to the sperm-head is very little indeed. Spectroscopic observations in certain tissues have shown the relative paucity of nucleotides in the nuclear sap (White[3]) but in view of the foregoing it would be interesting to examine by spectroscopical analysis, developing spermatids.

Wherever the nucleotides come from, either from the cytoplasm or the nucleus itself,—and the former possibility is very remote,—their original reactions are such that in the early spermatid they are of the ribose type and as in mitosis, they are converted into those of the desoxyribose type in the fully formed sperm-head.

There is yet another curious relationship between the chromosome and the sperm-head to be considered. The reproduction of the chromosome during mitosis (and meiosis) is dependent on the acquisition by the protein framework of a minimal quantity of nucleic acid charge. It is admitted that it is probable that here is involved not only a quantitative relationship between the protein and the associated nucleic acid but also a relationship of *arrangement* of the desoxyribose nucleotides with reference to the protein framework. In any case, assuming that the synthesis of nucleic acid in the nucleus has an important bearing on the reproduction of the protein framework of the chromosome, the synthesis of nucleic acid in the nucleus of the developing spermatid unattended by any attempt at or evidence of reproduction is full of interest. It is highly probable that the whole relationship of the protein and nucleic acid is a different one in the sperm-head from that in the mitotic chromosome. This itself is a matter of considerable interest, for by two essentially different vital processes, the synthesis of nucleic acid can take place in animal cells, (1) by mitosis and (2) by spermateleosis. This would impart a wholly different complexion to the process of spermateleosis and make the spermatozoon a highly specialised cell in more than one respect.

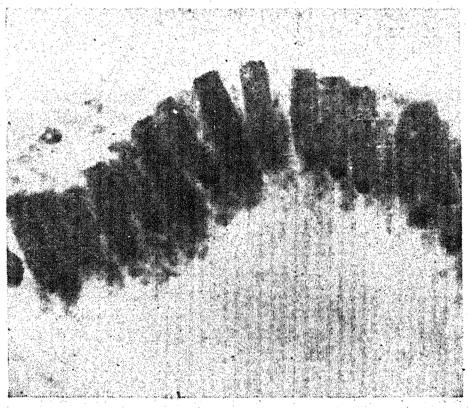


FIG. 2. Microphotograph of the developing spermatids of *Ichthyophis glutinosus*, showing the beginning of nucleination. × 1500.

The details of the process of nucleination of the spermatid nucleus are full of interest in this connection. In the Apodan spermatid with which the author[7] is particularly well acquainted, the following briefly are the facts: The spermatid nucleus is at first spherical and is in the resting condition. It gradually assumes an elongated cylindrical form and at the same time becomes fainter in its staining capacity. When this elongation has reached its maximum (which varies in the different species of Apoda examined) the nucleus begins to contract in length as well as in girth, and associated with this contraction in size is the beginning of the synthesis of thymonucleic acid. The nucleus, which till now was only very faintly staining, shows posteriorly a positive reaction with Feulgen and the narrowing nucleus gradually shows a deeper staining power. This synthesis of thymonucleic acid as evidenced by the staining reactions extends gradually forward till it pervades the entire nucleus, which now is narrower and shorter but a deeply staining cylinder. If we divide the nuclear history during spermateleosis in Apoda into two phases, the first phase is concerned only in the elongation of the nucleus, while in association with the second phase is a double phenomenon of shortening and consolidation as well as the synthesis of thymonucleic acid. By this time the cytoplasmic equipment of the elongated spermatid is so meagre that, as already observed, it is highly unlikely that any contribution of nucleotides

could be made by it. The staining reactions prove this. It is more probable, on the other hand, that the nucleotides in a ribose state exist within the nucleus itself and in the second phase of the nuclear history of the spermatid, are converted into those of the desoxyribose type.

Throughout spermateleosis there is a continuous process of concentration and reduction of the volume of the nucleus but while in the first phase, there is only reduction in volume, in the second, there is in addition, a synthesis of desoxyribose nucleic acid.

Much of the above account of spermateleosis refers to the Apoda (Amphibia) which illustrate the phenomenon admirably, but it is probable that other animals display much the same process.

It is, therefore, clear that nucleination, far from being associated *always* with division, occurs at least in one other condition, *i.e.*, in spermateleosis, but in a fundamentally different relationship and unassociated with the formation of definitive visible chromosomes. Chemically and even quantitatively, the protein and nucleic acid of the metaphase chromosome may resemble those of the ripe sperm-head, but in one case, the protein is a fibrous framework with which at certain localised areas, the nucleic acid becomes associated, while in the other case, no chromosomes are seen. In one case, the synthesis of nucleic acid is associated with division and in the other, it is unattended by division.

The subsequent history of the sperm nucleus is also interesting. After entry into the ovum, it exhibits reactions which fall under two different categories. In the sea-urchin, it becomes converted back again into a resting nucleus and from all existing accounts of the details of fertilization (Wilson[8]) it is in this condition that it fuses with the nucleus of the ovum. On the other hand, in Ascaris, soon after the entry of the sperm the nucleus almost immediately becomes organized into the definitive haploid number of chromosomes characteristic of the species, and in this condition, with the chromosomes distinct within the nuclear membrane, it approaches the female pronucleus. A spindle is soon formed —the spindle of the first cleavage division,— and on it by the dissolution of the nuclear membranes of the sperm and the ovum, the chromosomes are placed; so that in Ascaris no mingling or flowing together of the nuclear material is involved.

The difference between the sea-urchin and Ascaris would appear to lie in the interpolation in the former of a resting stage before the actual fusion of the sperm nucleus with that of the ovum.

The significance of this from our point of view is important. In the sea-urchin processes which are the reverse of what take place during spermateleosis must occur during the early stages of fertilization. Nucleination which occurred during spermateleosis is followed by denucleination during the early stages of fertilization, where the sperm nucleus gets back into the resting condition. Obviously this supports the view expressed earlier that spermateleosis is a remarkably unique phenomenon without parallel in any other aspect of cell life, where nucleination occurs with reference to the resting condition, and unassociated with division of the nucleus.

1. Miescher, F., "Die histochemischen und physiologisches arbeiten." Leipzig, 1897. 2. Steudel, H., & Peiser, E. *Z. Physiol. Chem.* 1922, **122,** 298. 3. White, M. J. D., "Nucleus, Chromosomes and Genes," in *Cytology and Cell Physiology*. Oxford, 1942. 4. Darlington, C. D., *Nature*, 1942, **149**, 66. 5. Caspersson, T., *Nature*, 1944, **153,** 499. 6. Seshachar, B. R., *Proc. Ind. Acad. Sci.*, 1943, **17,** 138. 7. —, *Proc. Nat. Inst. Sci.*, 1943, **9,** 271. 8. Wilson, E. B., *Cell in Development and Heredity*, New York, 1928.

THE INDIAN INSTITUTE OF ART IN INDUSTRY

THE Indian Institute of Art in Industry, which has, during the last five years, pioneered the art-in-industry movement, has been registered and invested with an All-India status. The Institute will have a secretariat in Bombay and representatives in other important centres. It aims at becoming "the central guiding force in the country's art applied to industry".

The Institute will develop the art in industry exhibitions and will also build up an annual industrial fair of goods of attractive appearance, and this will greatly stimulate trade in the immediate post-war period. The Institute will engage experts in commercial art and industrial design, and will assist in the training of teachers for government technical institutions. It is intended that as soon as possible a monthly magazine will be published, followed in due course by other types of bulletins. A register of commercial artists and designers will be compiled. The Institute will strive to become as rapidly as possible a valuable complement to industry in matters pertaining to design, packaging, and the various aspects of commercial art. It is understood that a substantial grant from the Central Government is now under consideration and it is hoped that Provincial Governments and Indian States will give generous support to the Institute. It is expected that a revenue of 5 lakhs of rupees will be forthcoming to enable the Institute to carry out its programme, and of this sum, it is estimated that two lakhs will be contributed by industrialists.

LETTERS TO THE EDITOR

THE FLUORSPAR DEPOSITS OF RAJ NANDGAON AND KHAIRAGARH STATES, EASTERN STATES AGENCY, CENTRAL PROVINCES

In this communication, attention is confined to the fluorspar deposits of the States of Raj Nandgaon and Khairagarh. These deposits were examined by Dr. Chhibber, while the collection was studied conjointly by him and Mr. I. C. Pandey.

There are two ways of approaching these deposits. One of them is *via* Raj Nandgaon and then a journey of 26 miles takes one to the deposits. They are also accessible from Dongargarh which is a railway station, about fifteen miles by road from these deposits.

Previous Literature.—There are passing references to this deposit by Thomas Oldham[1] and W. T. Blanford.[2] There is also a paragraph in the Director's Annual Report for 1938-39. Reference to this dposit is also made by Dr. M. S. Krishnan,[3] wherein it is stated that Dr. J. A. Dunn visited the deposit.

Physical Features.—These fluorspar deposits form two small hills running practically in a north-south direction and are separated by the Great Eastern Road. These hills rise from the surrounding flat granite country and the locality is locally called Chandi Dongri because of the association of the argentiferous galena with these deposits. The northern hill lies in the State of Khairagarh while the southern hill is situated in Raj Nandgaon State. The Khairagarh hill is about 70 feet above the level of the Road.

Geology.—The geology of the country is represneted by the following rock-types:—

(*iii*) Silicified Granite.
(*ii*) Fluorspar Pegmatite.
(*i*) Granite.

The country-rock is a porphyritic granite, clearly exposed in the streams. Outcrops of this rock are seen in places; otherwise it is covered with soil or subsoil, sometimes with a heavy over-burden. The following profile section was observed, in descending order, in a quarried face of the granite in the northern hill in the Khairagarh State:—

(1) Blackish soil mixed with gravel and humus in which pieces of fluorspar are occasionally found. It is about two feet in thickness.
(2) Reddish soil in which quartz grains are very conspicuous. It is locally known as *moorum.* It is lateritic in character and the felspar has changed into clayey material. It is about four feet in thickness.
(3) Below (2) decomposed granite is exposed in which felspathic veins are seen running in all directions.

Deposit of Fluorspar.—The locality, where fluorspar is known to occur, is locally known as *Chandi Dongri* (meaning silver hill) because of the association of argentiferous galena with the deposit. However, the argentiferous galena occurs only in very small quantity; it being almost absent in the southern Nandgaon hill.

The mineral fluorspar occurs in a pegmatite, which is intrusive into the granite and which runs in a dyke-like fashion practically in a north-south direction. It has a maximum width of about 64 feet and in places inclusions of the granite are enclosed in the pegmatite.

Khairagarh State.—The northern hill, as already noted, lies in the jurisdiction of the Khairagarh State and was being worked at the time of the first author's visit in November 1941. The overburden had been removed and fluorspar was being extracted from the central portion of the pegmatite. It has an average fluorspar content of about 22 per cent., a little more than that of the Nandgaon hill and the workable length is only about 400 feet from the road. The width is about the same as in the Nandgaon hill.

Nandgaon State.—The southern hill, across the road lies in the Nandgaon State. The dyke, in which fluorspar occurs, is about 30 feet in width on the average which in places dwindles down to 12-15 feet. The pegmatite appears to have almost vertical walls on either side. Towards the northern end, the dyke is more quartz-bearing, but it is also rich in fluorspar. Towards the southern end it assumes more felspathic character which has little fluorspar.

Mode of Occurrence of Fluorspar.—Fluorspar occurs in veins, the maximum thickness observed being about five inches. In some cases lenses of the country-rock also occur in these veins. Fine stringers are also commonly observed. In one place these veins were obsrved in coarse granite with pink felspar. Fluorspar and quartz are the main minerals forming these veins. It may be noted that blocks of what appeared like breccia were also observed. This breccia is apparently fault breccia and it is along this fault that the fluorite-bearing pegmatite intruded itself. Some of the blocks have a cavernous appearance filled subsequently with fluorspar, quartz and occasionally argentiferous galena. Sometimes fluorspar is deposited evidently in crevices in the rock.

The rock is highly crushed and is traversed by joint cracks running in several directions. Some of these cracks are hardly one-eighth of an inch apart and in these cracks fluorspar is deposited. Minute specks of green malachite are also observed.

Fluorspar, mostly mauve in colour, also occurs in irregular lanticles or patches. Those measuring four inches by two inches are not uncommon mut occasionally those having dimensions of two feet by three inches are also observed. Towards the crest of the hill the rock is richer in fluorspar than on the flanks. This mineral is also found associated with siliceous cavernous gangue, *e.g.*, near about 300 feet, from the main road, in the Khairagarh hill.

Physical Characters of Fluorspar.—The form is usually massive and compact. The colour is variable. It is whitish, greenish, bluish, violet-blue, pinkish and dark purple in colour almost approaching black. The streak is white. The lustre is vitreous. One set of cleavage is perfect. The fracture is splintery, subconchoidal. Hardness is 4. The specific gravity, as determined by Jolly's balance, is 3·0.

Microscopic Characters of Fluorspar.—The fluorspar occurs in granular form and also as metacrysts which show subhedral forms. One set of cleavage is perfect while the other is imperfect. It is observed to be intergrown with quartz and felspar which is clouded. In thin sections it is colourless but sometimes pinkish, purplish or bluish shades are to be observed. The mineral is isotropic. Some galena occurs in association. A little axinite and a few specks of chalcopyrite also occur.

Chemical Composition.—The following two chemical analyses of almost average specimens of the fluorspar rock were done by Mr. I. C. Pandey.

	I	II
SiO_2 ..	19·56	10·12
R_2O_3 ..	8·32	9·12
$CaCO_3$ ..	3·105	5·10
CaF_2 ..	68·52	72·15
H_2O+ .	0·32	1·32
H_2O-		
	99·825	97·81*

* PbO is present in small quantity.

I and II.—These almost average specimens are from the Khairagarh hill, where fluorspar was being extracted in November 1941.

The analyses show that the percentage of silica, which is in the form of quartz, varies from 10·12 to 19·56 while CaF_2 is in the neighbourhood of about 70 per cent. $CaCO_3$ varies from 3·105 to 5·10 per cent.

Working of the Deposit.—It appears that Messrs. Tata Iron and Steel Co. have carried on considerable prospecting in these hills. Towards the end of 1941, they had applied both to Nandgaon and Khairagarh States for mining leases, which were likely to be granted shortly. The Tatas were quarrying the rock with manual labour and they hoped to raise about 3,000 tons of fluorspar *per annum* with about 100 workmen. This fluorspar will be utilized in the manufacture of steel. In November 1941, experiments on hand-sampling, hand-dressing, etc., were being carried on. After quarrying, the rock is hammered into small pieces and those of fluorspar are separated by hand-picking from the gangue. Several stacks of fluorspar were found lying near the hill.

Origin of Fluorspar and History of Igneous Activity.—The history of igneous activity of this deposit may be briefly described as follows:—

(1) First, there was the intrusion of the main mass of the granite.

(2) In the granite there was the intrusion of the felspathic pegmatitic dyke. It has almost vertical walls and stands out very clearly from the surrounding decomposed granite.

(3) The pegmatitic phase was followed by the pneumatolytic phase when the vapours of fluorine, silica, etc., were responsible for the deposition of secondary clear quartz, fluorite, etc. It was usually observed that clear quartz and fluorspar generally occur together, shewing that vapours of fluorinee and SiO_2 acted together. When the dyke is entirely felspathic, it is almost surely devoid of fluorspar. In the siliceous or quartz-bearing rock, fluorspar is more likely to occur.

(4) Finally came the hydrothermal phase which was responsible for the dissolution of the felspathic material and the deposition of whitish chalcedonic or yellowish jaspery silica instead. It was observed that fluorite in this material was conspicuous by its absence. It appears that this form of silica was definitely deposited by the hydrothermal phase and by that time the vapours of fluorine, etc., belonging to the pneumatolytic phase, had ceased activity. Honey-combed cavernous structure is observed in places where quartz of the granite is still intact but by the dssolution of

the felspar, the cavernous structure has developed. These etched out spaces were subsequently filled with the white or yellowish silica.

Department of Geology,
Lucknow University,
November 16, 1944.

H. L. CHHIBBER.
I. C. PANDEY.

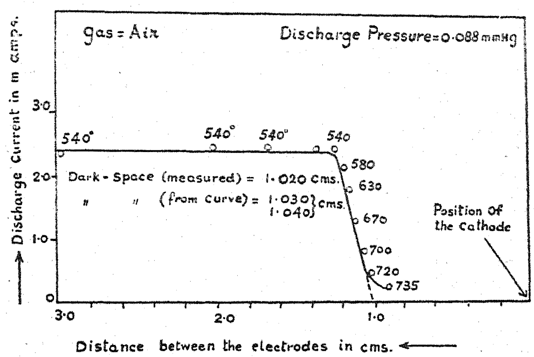
1. *Rcds. G.S.I.*, 1868, **1**, 37. 2. —, 1870, **3**, 44. 3. —, 1939, **74**, 406.

ON THE CATHODE DARK-SPACE OF A GLOW DISCHARGE IN GASES AT LOW PRESSURES

A NUMBER of experimenters [1,2,3] have studied the characteristics of the cathode Dark-Space and they all agree that this is the most active region of a glow discharge. The views held by different investigators on the mechanism of the flow of current across the Dark-Space are, however, very divergent. Thomson[4] believes that the ionisation in the space is caused by electrons which themselves are emitted from the cathode surface by the impact of the positive ions so produced. This theory finds a good support from the experiments of Oliphant[5] on the secondary electron emission from metals by positive ions. The entire supply of the ions to the cathode is, according to them, from the Dark-Space itself and very few of them flow into it from the negative glow and particularly so when the discharge is normal. Moreover, they consider it probable that on account of their high density in the Dark-Space some of the ions flow back into the negative glow. Loeb[6] takes the reverse process to be more probable. Ryde[7] and Compton and Morse[8] also hold that it is the negative glow which acts as a source of the positive ions. They further assume that this section of the discharge behaves like an emitter of the ions and the cathode as a collector of them, the relation connecting the cathode fall, the Dark-Space length and the discharge current being of the same form as the Langmuir's Space-Charge Law which is true for electronic emission from a hot metal in a high vacuum. There is, however, no direct experimental evidence in favour of any of the above assumptions.

We have carried out experiments with two plane parallel electrodes in a discharge tube, the anode being moveable. It is observed that as the anode is brought closer to the cathode there is no variation in the discharge current or the voltage till the former reaches a point in the negative glow a few mm. away from the boundary of the cathode Dark-Space. If the anode is pushed further towards the cathode the current regularly falls but the voltage required to maintain the current rises continuously. The fall in the current is linear with the displacement of the anode till it reaches a point near the edge of the Dark-Space. Beyond that the current diminishes much more gradually.

A large number of curves connecting the discharge current and the distance between the electrodes have been obtained. The curve in the figure typifies the results in Air and Oxygen. The voltage required to maintain the



discharge current at varying distances between the electrodes is given along the curve at each step. If the straight falling part of the curve is produced to cut the distance axis the point of intersection of the two lies away from the cathode equal to the width of the cathode Dark-Space which was measured usually with the help of a cathetometer. This applies practically to all the curves.

The experiments have been carried out in air over a pressure range, 0·043–0·142 mm. Hg, voltage range, 350-950 volts and current range, 1·2-4·0 m.amps.; corresponding values for oxygen are 0·112-0·165 mm. Hg, 400-520 volts and 1·8-3·2 m.amps.

We have come to the following conclusion from these experiments:—

1. The positive ions reaching the cathode do not all come from the Dark-Space but a considerable number of them flows into the Dark-Space from the negative glow under all conditions of the discharge studied.

2. The discharge current is carried across the common boundary of the Dark-Space and the negative glow both by the cathode rays and the positive ions travelling in opposite directions.

3. The length of the negative glow which acts as a source of the positive ions to the Dark-Space depends upon the discharge voltage and pressure.

Details of the experiments will be published elsewhere.

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S. H. ZUBERI.

Physics Department,
Muslim University,
Aligarh,
January 2, 1945.

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GROWTH OF THE SHOOT IN *ASPARAGUS RACEMOSUS* WILLD

LINEAR growth of the shoot can be observed in a few plants without the aid of an Auxanometer or a horizontal microscope. In the Cucurbitaceæ the rate of growth is rapid but the elongation of the stem is accompanied by the growth and the increase in size of the leaves, axillary shoots and flowers. Kraus[1] and Smith[6] have recorded daily increase in growth in *Bambusa* which is quite rapid. The total elongation in *Bambusa*, however, is the result of the activity of several growth zones and a younger internode might start growing after the older has entirely ceased to grow. There is thus a periodic rise and fall in the net growth-increase or elongation.

In *Asparagus racemosus* Willd., the shoot in the beginning elongates at a very rapid rate and the growth is linear till the axillary shoots appear, as the leaves are reduced to scales. The growth of axillary shoots is delayed till the main shoot has attained some length. The axillary shoots also grow very rapidly but then the main shoot grows very slowly. Till the axillary shoots begin to grow rapidly, the growth of the main shoot is appreciably great and can be directly measured by means of a scale without the help of an Auxanometer or a horizontal microscope. The writer[2, 3] has already recorded the 12-hourly rate of growth of a number of shoots in *Asparagus racemosus* and *Asparagus sprengrii.*

It was also observed that the rate of growth for the day is 25 per cent. higher than at night. Periodicity in this matter—higher rate of growth during day than at night—was observed in the case of shoots of both the species. Further observations were made to elucidate this point. A number of shoots are given out by *Asparagus* during spring. They grow rapidly till they attain a definite height, without producing axillarly shoots. The height attained by different shoots of the same plant was 114·5 cms., 116·5 cms., 127·0 cms., and 78 cms. This plant was four years old and was growing in field-conditions in a 12-inch flower-pot. Older plants in the ground grow more than 350 cms. before the axillary shoots are formed.

The growth-rate is slow in the beginning, then it becomes rapid, attains maximum rate after which it gradually falls off. The figures in the second row begin with slow rate of growth—·8 cm., ·4 cm. for 12 hours and later on, growth was uniformly higher for some days having reached a maximum of 6·7 cms. for 12 hours after which it fell off quickly when the axillary shoots appeared. This is also true in the other three cases.

The record of the 12-hourly rate of increase in centimeters of the shoot of *Aspearagus racemosus* is noted in Table I.

The maximum increase in the four cases was:—

	Per 12 hours	Per minute
I	8·5 cms.	·12mm.
II	6·7 cms.	·09mm.
III	9·9 cms.	·13mm.
IV	8·9 cms.	·12mm.

Kraus[1] noted an increase of 0·4 mm. per minute in the stem of *Bambusa* and Smith, A.M.[6] observed elongation at a rate of nearly 0·4 mm. per minute. These varying results in *Bambusa* may be due to various causes.

TABLE I

(Observations were made at 8 a.m. and 8 p.m. each day) D = Day, N = Night

	16th April	17th April		18th April		19th April		20th April		21st April		22nd April		23rd April		24th April		25th April		26th April		27th April	
Shoot	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D
I	6·6	6·4	7·0	5·5	6·0	4·0	8·5	5·0	7·0	5·5	5·0	3·5	4·8	2·7									
II	·8	·4	3·0	3·2	5·4	3·5	4·9	6·0	6·5	6·5	6·2	5·1	6·7	6·0	5·5	1·0	0·5	0·5					
III					2·0	2·5	5·4	5·0	6·0	7·5	5·5	8·0	6·7	8·5	9·1	6·5	8·7	5·0	6·5		13 0	4·5	4·5
IV													4·5	7·0	7·5	6·0	7·0	4·1	7·9	8·9	1·2	6·4	
	Sl	ow			R	ap	id			M	ax	im	um								S	lo	w

TABLE II

	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D	N	D
I	6·4	7·0	5·5	6·0	4·0	8·5	5·0	7·0	5·5	5·0	3·5	4·8	2·7					
II		3·0	3·2	5·4	3·5	4·9	6·0	6·5	6·5	6·2	5·1	6·7						
III					2·5	5·4	5·0	6·0	7·5	5·5	8·0	6·7	8·5	9·1	6·5	8·7	5·0	6·5
IV													7·0	7·5	6·0	7 0	4·1	7·9

D—Day. N—Night.

Moller, A.,[5] observed an increase of 5 mm. per minute in the fruitification of *Dictyophora*.

There is periodicity in the day and night rates of elongation. Generally the increase in the day time is higher than in the night and the periodicity is almost regular except in shoots I and III on 21st April. The suggestive figures of elongation are given in Table II.

Thus elongation during the day is generally higher than in the night. This has been observed earlier by the writer[3] and further observations were made to elucidate this point. This may be due to the fact that the plant is adding new material continuously during the day time as suggested by Blackman,[4] or there is more rapid translocations of the food materials from the tubers during the day than at night.

Jaswant College,
Jodhpur, SHANTI SARUP.
January 18, 1945.

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ELECTRIC POTENTIAL OF THE EARTH'S SURFACE

It has been commonly assumed that the electric potential of the earth's surface is a fixed quantity, and that its magnitude is zero. It should be worthwhile, however, to see whether this concept is correct from the standpoint of modern theory.

According to geophysics the central portion of the earth's interior is a spherical core of a hot, ionised, liquid metallic mass of radius 3,500 km.[1] rotating round the terrestrial magnetic axis,[2] and that the earth's magnetism requires that it be negatively charged. It has also been computed that there emerges at the surface of this spherical core a strong electric field varying between 10^6 volts per cm.[3] and 10^8 volts per cm.[4] Around this hot core is the comparatively cold earth's crust, made up of crystalline rock, which is 2,900 km. thick, and which extends to the earth's surface.

During the process of cooling through the ages, there is a considerable thermo-electric current passing between the surface of the core and the underside of the crust.[5] There is also a negative charge on the earth's surface which is indicated by the presence of the atmospheric electric field which at sea level varies from 100 to 500 volts per metre, and approaches a zero value at the uppermost layers of the atmosphere, that is to say, it varies from one to five times its basic value. There is also considerable flow of an air-earth electric current from the upper air to the earth's surface. Around the earth, further, there is the outer shell of the upper atmosphere, which is known to bear a positive charge, and the whole system is enveloped in the corpuscular radiation which the sun is continuously sending out into the space surrounding it.

Since we know by induction that there must be a positive "surface" charge on the underside of the earth's crust; that there is a negative surface charge on the earth's surface; that thermo-electrons continually enter the underside of the crust; that air-earth current electrons leave at the earth's surface; that the strength of the core's field is of the order of 10^6 volts per cm. and that the electric fiel which emerges at the earth's surface is merely a few volts per cm., we must infer that there exists an exceedingly steep difference of potential between the under and the upper surfaces of the crust, and that the electric potential of the earth's surface with respect to the core must thus be of a very high order of magnitude, and not zero as has been commonly assumed.

We further know that corpuscular radiation from the sun so affects the positively charged shell of the outermost upper atmosphere and consequently, the earth's total charge, that the terrestrial electric field has been found to vary in direct proportion.[6]

We are unfortunately not in possession of adequate data on the exact nature of variation of the terrestrial electric field within the earth's crust, but it must obviously satisfy the relationship $y = f(Q, x)$ in which y is the field strength and Q, the earth's charge, and that the electric potential P, of the earth's surface must be given by P=2900 km. $f(Q)\,dx$, x being height of a point on the earth's surface measured from core's surface. Since, however, Q is a quantity which we found, varied directly as the terrestrial electric field, which we know changes from time to time, it is obvious that the electric potential of the earth's surface with respect to the core is not a fixed quantity as is commonly assumed but that it varies over a wide range of values, and that it does so in direct proportion to the magnitude of the field as registered by an electrograph at the earth's surface at a given instant of time.

Colaba Observatory,
Bombay, ALFRED B. ARLICK.
January 25, 1945.

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AN ELECTROLYTE-FREE MEDIUM FOR THE FROG HEART AND GRADED RESPONSES OF THE HEART MUSCLE

RINGER has shown that for the proper functioning of the heart, the external medium must contain suitable amounts of sodium, calcium and potassium. It is generally believed that for the contraction of all kinds of muscle, these ions are necessary. Singh (1944) has, however, shown that the frog stomach contracts spontaneously and remains irritable to electric current for about 4-6 hours in a half tonic solution of sucrose.

It has been found that the electrolyte-free medium for the frog stomach is equally good for the frog hearts used in this series of investigations. When perfused with half tonic sucrose solution, the frog heart presents the same series of phenomena as the frog stomach. At first there is a contracture followed by depression of excitability. The heart then recovers and continues to beat from half an hour to two hours; the rhythm and relaxation are, however, slow (Fig. 1). For some hearts,

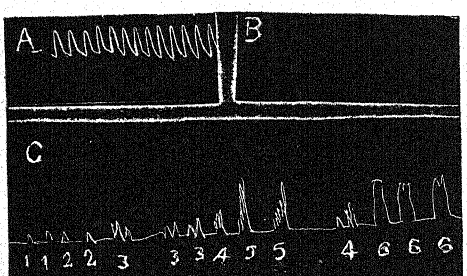

FIG. 1. A. Beating of the frog heart in Ringer. B. Beating of the same heart in isotonic solution of sucrose, after 25 minutes immersion. The heart may continue beating slowly for about two hours in the absence of electrolytes. It may remain irritable to induction shocks for another two hours.

C. Frog heart. Graded responses. Contractions No. 1 by 1·5 v for 5 sec. (D.C.).

Contraction No. 2 by 3 v D.C.
do 3 do 4·5 v D.C.
do 4 do 6·0 do
do 5 do 7·5 do
do 6 do 9 v do

In contraction Nos. 1, 2 the heart has only responded to make. In contractions No. 3, 4, 5, the heart has responded by rhythmic contractions. In contraction No. 6, the heart has responded by tetanus.

an isotonic solution of sucrose was found to be better than half tonic sucrose, but if the heart had come to a standstill in the isotonic sucrose, it was revived by the half tonic sucrose solution. After the heart had stopped beating in the electrolyte-free medium, it remained irritable to induction shocks for a considerable time (one to two hours). It is thus remarkable that the heart should contract in the absence of all electrolytes; this shows that excitation in the heart muscle is produced by ions within the muscle fibres, and that the function of ions in the Ringer solution is to mutually antagonise one another.

Another remarkable phenomenon presented by these hearts was, that they behaved like plain muscle, in responding by contracture to acetylcholine and excess of potassium. As plain muscle does not obey the "All and None" law, it is to be expected that the same law would not hold good for these hearts. This was actually found to be the case. When stimulated with direct current by voltages ranging from 1·5 to 20, the responses were graded [Fig. 1 (c)]. The contraction produced by break induction shock was bigger than that produced by make shock.

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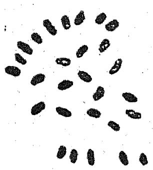
February 19, 1945.

1. Singh, I., *Curr. Sci.*, Oct. 1944,

CHROMOSOME NUMBER OF *SESAMUM LACINIATUM*, KLEIN.

ONLY three species of *Sesamum* are reported in the Indian flora (Hooker). Of these, *Sesamum orientale* Linn. (=*Sesamum indicum* D.C.) is the commercial til. Both *Sesamum prostratum* Ret. and *Sesamum laciniatum* Klein. are prostrate, perennial weeds. They closely resemble one another but for the fact of the leaves of *Sasamum laciniatum* being deeply pinnatifid. The capsules of *Sesamum laciniatum* are smaller than those of *S. prostratum*. The chromosome number of *Sesamum orientale* has already been determined to be $2n = 26$ in this laboratory (Sreenivasan, 1942). Cytogenetical work in this genus has been in progress here for some years now. Interspecific hybridisation between *Sesamum orientale* and *Sesamum prostratum* has been effected and the sterile hybrid has been made fertile by the artificial induction of amphidiploidy. Cytological and cytogenetical details connected with this work will appear elsewhere as a paper. The fertile amphidiploid is being grown through several generations and its seeds compared with those of *Sesamum orientale* in all respects, quality, quantity, oil yield, etc. It has been found that while *Sesamum orientale* is a seasonal herb, this fertile amphidiploid is perennial, flowering and fruiting throughout the year. In connection with these studies, the chromosome number of *Sesamum prostratum* ($2n = 32$, $n = 16$) both somatic and meiotic, has been determined in this laboratory (Krishnamurthy). The chromosome number of *Sesamum radiatum*, an Argentine species, was reported some years ago to be $2n = 64$ (John and Narasingha Rao). So far as we are aware, the chromosome number of the other Indian species of *Sesamum*, namely, *Sesamum laciniatum* has not been recorded. Specimens of this species were collected from several parts of India and are being grown in the University Botanical Gardens. We are carrying on hybridisation work between this

species and *Sesamum orientale* on the one hand and between this species and *Sesamum prostratum* on the other. Full cytological and cytogenetical details relating to this investigation will be published in due course. In the meantime the chromosome number of *Sesamum laciniatum* has been determined to be $2n = 28$ (Fig. 1). Prochromosomes which were a com-



mon feature in the other species of *Sesamum* are found to be very prominent in this species also. A full account of the prochromosome-chromosome relationship, based on observations on these species, and their correlation to the nucleolar cycle, will form the subject of a separate paper.

Botanical Laboratory,
Annamalai University, T. S. RAGHAVAN.
Annamalainagar, K. V. KRISHNAMURTHY.
March 6, 1945.

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ON THE OCCURRENCE AND DISTRIBUTION OF *POTHOS SCANDENS* LINN., VAR. *HELFERIANUS*, ENGL. IN BENGAL

IN the province of Bengal *Pothos scandens* Linn., an epiphytic climber is found growing upon several kinds of plants. Prain[3] in 1903 reported that *Pothos scandens* Linn. occurs in North Bengal and Chittagong but there is no mention of any other variety or species of the same genus from any other part of the province, though other species were reported by Hooker[2] in 1893 from the whole of India. The latter author also corroborated Prain and stated that the only species of *Pothos*, found in Bengal, is *Pothos scandens* Linn. Prain[4] further in 1905 in his survey of the flora of 24-Pergannhas, Hoogly and Howrah districts did not mention the occurrence of any species or variety of *Pothos*.

Pothos angustifolius Hook. f. (non-Presl.), as recorded by Hooker,[2] is according to the latest nomenclature is reduced to a variety of *Pothos scandens* Linn. by Engler[1] and is named *Pothos scandens* Linn., var. *Helferianus* Engl.

In the latter part of December 1944, and in the beginning of March 1945, the present writer came across in course of excursions in the sub-urban villages of the city of Dacca (Bengal) and collected *Pothos scandens* Linn. var. *Helferianus* Engl., and found it climbing on the bases of several trees in shady places. Since the first collection, Mr. Murari Prosad Guha, Lecturer in Botany of this College, collected this plant from Jamuria, Tangail (Dist. Mymensingh) in the latter part of January 1945 for the writer's anatomical studies. He also brought the flowering specimens of *Pothos scandens* Linn. Both Mr. Guha and the writer could not procure any flowering specimens of this variety during this period.

Dr. S. K. Mukherjee, Curator of the Herbarium, Royal Botanic Gardens, Sibpore, Calcutta, very kindly informs the writer that the *Helferianus* variety of *Pothos scandens* was collected from Agartalla (Dist. Tipperah) and the neighbourhood of Calcutta. But it is likely that the plant was collected after Prain[3] had recorded his observations in his careful survey.

Rendle[5] wrote that the genus *Pothos* with its fifty species is chiefly Malayan. Hooker[2] collected *Pothos angustifolius* Hook. f. (non-Presl.) (= *Pothos scandens* Linn. var. *Helferianus* Engl.) from Tennasserim, Burma—a place 950 miles away (coast to coast) from the border of the province of Bengal and where the Malayan vegetation is dominant. From the nature of distribution it becomes evident that the plant had migrated from Tennesserim (Burma) and entered into the province *via* Chittagong and gradually spread over other districts, *e.g.*, Tipperah, Mymensingh, Dacca, etc., in course of about fifty years. Afterwards it has become naturalised and formed a unit of the local vegetation. The writer also surmises that this plant was brought and introduced as a garden climber in the neighbourhood of Calcutta for its nice small unifoliate leaves and from there it had become an escape and spread over that locality after Prain's[3] survey.

Botany Department,
J. I. Collоge, Dacca, R. M. DATTA.
March 7, 1945.

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HAIRINESS OF COTTON LEAVES AND ANTI-JASSID RESISTANCE

THE evolution of resistant varieties has been regarded as the most effective line of defence against the jassid, *Empoasca devastans* Dist., which is a major pest of cotton in the Punjab, Sind and Madras. It has been generally believed that varieties with hairy leaves are more resistant to jassid attack than those not possessing this character. For this reason cotton breeders have bred for hairiness in evoly-

ing jassid-resistant types. A note of warning was, however, sounded against placing exclusive and excessive reliance on leaf hairiness (Afzal Husain and Lal, 1940). It was suggested that hairiness might be a mere indicator rather than the actual factor of resistance, and that it would be by discovering the real and true cause of resistance; that the work of breeding resistant varieties could proceed on scientific basis.

Recently Afzal and Abbas (1943) have put forward the view that, although hairiness by itself does not confer any resistance on cotton plants against jassids, it is well enough associated with 'resistance' and, being easily recognisable and workable, is a safe character for the breeder to utilise. They, therefore, recommend breeders to select or evolve only very hairy varieties for areas liable to severe jassid attacks. The questions that arise are: Would scientific breeders be justified in accepting the position that they breed for a character, which in itself is of a doubtful value but serves only as an indicator of resistance? And, secondly, to what extent would such an indicator keep true to its role under varying conditions of climate and culture and in the permutations and combinations of genes in breeding?

It was shown by us (Afzal Husain and Lal, 1940) that the resistance of hairy varieties was due not to the inability of the jassids to feed on the hairy types, but to their mability to oviposit on them and, therefore, the jassid-resistant character should be sought for in the leaf veins —the seat of oviposition. Afzal and Abbas (*op. cit.*) state that Verma and Afzal (1940) tentatively conclude that the 'toughness of the cuticle of the leaf vein, which prevented the entry of the ovipositor, was the primary character which made the plant resistant,' but consider that toughness cannot be of much practical help to breeders, who must have a quick and ready means of identifying resistant plants and the determination of the relative toughness of the leaf veins involves laborious and delicate work. Is such an attitude justifiable? Should not greater reliance be placed on future research to solve the question of measuring the toughness of leaf veins quickly and simply if this proves to be chief factor imparting resistance?

If hairiness is closely linked with the jassid-resistant character and toughness of leaf vein is that character, then a very hairy leaf should also have a tough cuticle of its leaf veins. It should be valuable to determine this correlation. Unfortunately Afzal and Abbas carried out no experiments to throw light on this important point. Instead, they felt satisfied by the correlation between hairiness and resistance, observed in pure varieties as well as some hybrid progenies. On this basis they conclude that we were misled into casting doubt on the value of hairiness as an indicator of resistance, because he worked with pure varieties only, and, secondly, that errors (?) in our classification of varieties, in respect of jassid resistance, vitiate our findings. The suggestion, therefore, is that hairiness and resistance may be independent characters in pure varieties but not under hybridisation. The only evidence for this generalisation is the association of hairiness and resistance observed, in a small number of plants, of only one hybrid progeny; the rest of their observations, as ours, were made on pure varieties. Afzal and Abbas have neither given any genetic explanation as to why and how hairiness and resistance must be invariably associated together in breeding, nor have they tested a sufficiently large number of hybrid progenies, under different climatic and cultural conditions, to warrant their conclusions. In the absence of such explanations or tests or both, of what value is their recommendation to choose only hairy varieties for jassid resistance? We maintain, without fear of contradiction, that the degree of hairiness varies with the age of the plant and of the leaves as well as under different climatic conditions and cultural operations. If such be the case, would not the same variety be more hairy in one area and less in another, without, in any way, altering its resistance to jassid attack?

Regarding our alleged error in classifying 43 F as susceptible, which Afzal and Abbas observed to be resistant, the classification was not due to error but to the erratic behaviour of the variety itself, as was pointed out by Lal (1937). The general statement by Afzal and Abbas (*op. cit.*) that 'in all previous literature on hariness in relation to jassid, no mention has anywhere been made of the position of the leaf on the plant' is also not justified, since exactly the same and other precautions were taken by us (Lal, *op. cit.*) in choosing leaves for the measurement of their hairiness, as indicated by the authors.

K. B. LAL.
M. AFZAL HUSAIN.

April 9, 1945.

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ON THE FORMATION OF AUXOSPORES IN *BACTERIASTRUM*

AUXOSPORE-FORMATION is known only in a few species among the Centrales. Any new case of auxospore-formation in this group is always interesting. This process does not appear to have been recorded so far in the genus *Bacteriastrum*. The author, while working on the marine plankton Diatoms of the Madras Coast, observed the formation of auxospores in *Bacteriastrum varians* Lauder. A brief account of the process is given here.

During auxospore-formation, the valves of the mother-cell move apart and the cell protoplast emerges out surrounded by a delicate membrane, the perizonium [Figs. 1 (*a*) and

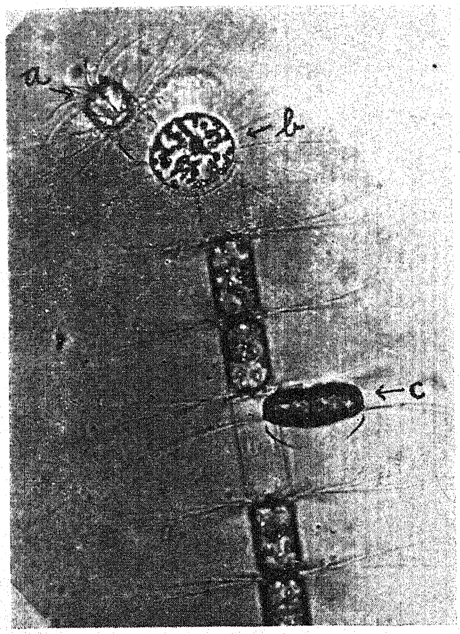


FIG. 1

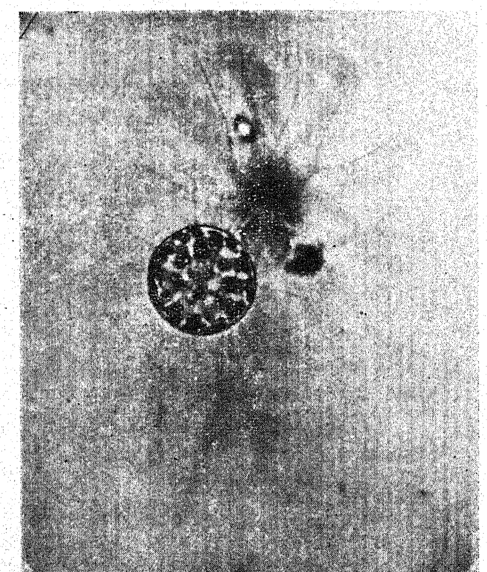
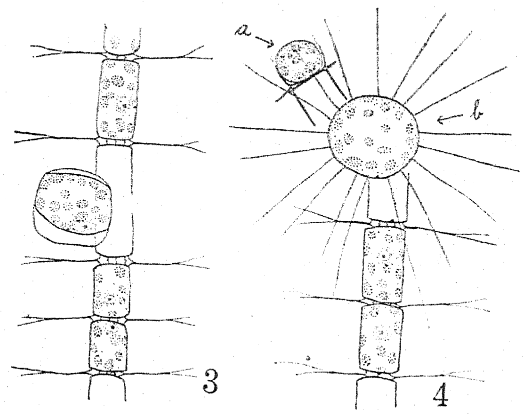


FIG. 2

4 (a)]. The protoplast after coming out of the valves (auxospore), gradually grows until it reaches a very large size. The contents of this auxospore then contract from one side of the perizonium first and secrete a valve. The contents then contract from the opposite side also and secrete the second valve (Fig. 3).



FIGS. 1–4. *Bacteriastrum varians* Lauder.

Fig. 1. Photomicrograph of a chain of cells showing auxospore-formation ; *a*, the protoplast of a cell which has emerged out of the valves ; *b*, new cell formed by auxospore-formation seen in valve view ; *c*., another new cell formed by auxospore-formation seen in girdle view. Note the ruptured perizonium. × 350. Fig. 2. Photomicrograph of a new cell formed by auxospore-formation seen in valve view. × 350. Fig. 3. Auxospore-formation in one of the cells of a chain. Note new valves being secreted inside the perizonium. × 350. Fig. 4. Same as Fig. 1. Only a portion (*a* and *b*) of Fig. 1. shown. × 350. All from living specimens.

As the valves are secreted the characteristic spines or setæ of the Diatom are also developed [Fig. 1 (b) and 4 (b)]. The setæ develop in the same manner as was observed by Iyengar and Subrahmanyan (1944, p. 118) during the vegetative division of the same Diatom. The perizonium becomes ruptured and the new cell becomes free [Fig. 1 (c)]. The new cells have a diameter about two and a half times that of the mother-cell of the auxospore (Fig. 2). Vegetative divisions then take place in the new cell and soon a chain of cells is formed.

Auxospore-formation takes place in the chains of cells which through successive vegetative divisions have become very narrow in diameter. Only one auxospore is formed in each cell, but auxospore-formation may take place simultaneously in several cells of the same chain.

The author wishes to express his indebtedness to Prof. M. O. P. Iyengar for his kind help and guidance during this investigation.

University Botany Lab.,
Madras, R. SUBRAHMANYAN.
April 24, 1945.

1. Iyengar, M. O. P., and Subrahmanyan, R., "On the Structure and Development of the Spines or Setæ of some Centric Diatoms," *Proc. Nat. Acad. Sci., India*, 1944, **14**, Pt. 3, 114–124.

TWO NEW RECORDS OF THE SPECIES OF THE GENUS *TRICHURIS* FROM INDIAN RUMINANTS

IN the paper are recorded, *Trichuris parvispiculum* from goats and sheep and *Trichuris discolor* from cattle and buffaloes. *T. parvispiculum* is previously known from goats in South Africa Ortlepp (1937) while *T. discolor* was originally described by V. Linstow (1906) from Ceylon. *T. parvispiculum* is a very common parasite of sheep and goats in the Punjab and United Provinces and was collected from Sialkot, Lahore, Multan, Delhi, Mukteswar-Kumaon and Izatnagar. *T. discolor* is on the hand rare and has been collected only from five cases out of fifty so far examined. Those were collected twice from Mukteswar, once from Izatnagar and twice from Sialkot. Examination of fæces of calves at Izatnagar showed that calves of about 1½ years of age always harboured trichurids. It has previously been reported by the author (paper in press) that *Trichuris globuloso* is a very common parasite of sheep and goats and occurs along with *T. parvispiculum*. The cattle slaughtered in localities where this parasite occurs, do not harbour *T. globulosa* though it has been reported from these animals from other countries.

Description of *T. parvispiculum* is not given in the paper as the material tallies in all essentials with that of the original author. A character not mentioned by him is that there are

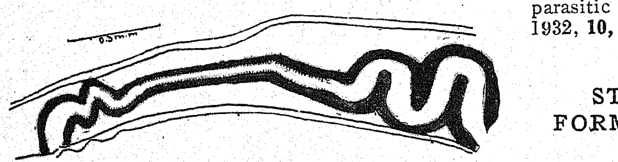


FIG. 1. *T. discolor;* Vagina

cuticular vesicles on the anterior part of the species. Presence of cuticular vesicles has been mentioned by Hall (1910), Solomon (1932) and Baylis (1935) in the species *T. leporis, T. spiricollis* and *T. mettami* respectively.

Host: *Capra hircus* and *Ovis aries*.
Location: Cæcum.
Locality: Indicated in the text.

It is not the intention of the author to dwell of characters already described by V. Linstow and hence only characters not previously described and considered useful in the proper identification of the species are included. The description is based on thirty individuals.

Male: Internal genitalia. Vas deferens measures from 2·4-3·15 mm. and ejaculatory duct 8·6-10·2 mm. long. The muscular constriction which joins the two parts is about 0·27 × 0·18 mm. Cloaca varies 1·55-1·7 mm. in length with the spicular tube joining it 0·55-0·85 from the posterior end. The ejaculatory duct pursues a somewhat wavy course for some distance from its start and is approximately about three times the size of vas deferens and seven times the size of cloaca. Testis starts in the region of cloaca, is straight in about one-third of the ejaculatory region, becoming moderately convoluted thereafter while in the region of vas deferens it is beaded.

There are vesicular swellings on the anterior end and cuticular vesicles and plaques at some distance from the anterior end. There is a conical papilla on either side of the posterior end.

Female: Vagina after about two proximal curves is straight for some distance and is again followed by a few curves before joining the uterus. The diameter of the straight middle part is even throughout, is less than that of the proximal curves and is at the same time less muscular.

Host: *Bos indicus* and *Bos bubalis*.
Location: Cæcum.
Locality: Mukteswar-Kumaon, ,Izatnagar, U.P., Sialkot (Punjab).

Military Dehydrated Meat Factory,
Agra, M. M. SARWAR.
May 7, 1945.

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STUDIES ON THE CATALYTIC FORMATION OF DI-OLEFINS FROM MONO-OLEFINS

(*a*) *Chemical Equilibrium in Butadiene*-1, 3 *Formation from Butene*-1 *at Low Pressures*

IN view of the difficulties involved in the determination of chemical equilibrium in the dehydrogenation of butene-1 to butadiene-1, 3, at atmospheric pressure, even in the presence of a highly active catalyst such as Cr_2O_3-Al_2O_3, an apparatus has been specially devised to study the reaction at the lower pressures of 10-50 mm. of mercury and in the temperature range of 360-540° C. The reaction has been studied in detail over the following three catalysts:

(1) Cr_2O_3-Al_2O_3 (5 per cent.); (2) Cr_2O_3-Al_2O_3 (5 per cent.)-V_2O_3 (2·5 per cent.)-Mo_2O_3 (2·5 per cent.); (3) Cr_2O_3-Al_2O_3 (5 per cent.)-Cu (10 per cent.), of which the catalyst No. (3) promoted by copper has been found most efficient. The equilibrium constant of the reaction has been calculated from the equation,

$$K_p = \frac{Px^2}{(1 - x^2)}$$

where x is the degree of dissociation of butene-1 and P is the total pressure in atmosphere. From the value of K_p, free energy of the reaction has been evaluated by using the relation, $\Delta F_T = -RT\ln K_p$ The following

values of K_p and ΔF_T for reactions at five different temperatures have been obtained (Table I).

TABLE I

Temperature °C.	K_p	ΔF_T (Calories)
370	0·000244	10,620
410	0·000823	9,642
440	0·002080	8,748
470	0·004703	7,911
500	0·008668	7,294

From the above values of K_p, the following mean value of the heat of reaction (temperature range 370-500° C.) is obtained:

$$\Delta H_T = 28{,}600 \text{ calories.}$$

The free energy as a linear function of temperature is expressed by the equation: $\Delta F_T = 29{,}352 - 28{\cdot}58\,T$. The temperature of neutral equilibrium is: $T_0 = 744°$ C.

(b) *Chemical Equilibrium in Isoprene Formation from 3-Methylbutene-1 at Low Pressures*

Chemical equilibrium in the dehydrogenation of 3-methyl-butene-1 to Isoprene has been studied at pressures of 10 to 35 mm. of mercury and in the temperature range of 330-450°C., over Cr_2O_3-Al_2O_3-V_2O_3-Mo_2O_3 as catalyst. To maintain the activity of the catalyst steady, it was periodically activated by treatment with hydrogen at 550-575° C. From the values of K_p, the following thermodynamic characteristics of the reaction have been obtained (Table II).

The mean value of the heat of reaction: $\Delta H_T = 27{,}120$ calories. Free energy as a linear function of temperature: $\Delta F = 27{,}570 - 27{\cdot}19$ T.

Temperature of neutral equilibrium:

$$T_0 = 671{\cdot}5° \text{ C.}$$

TABLE II

Temperature °C.	K_p	ΔF_T (Calories)
330	0·000,261	9,880
370	0·001,020	8,800
410	0·003,752	7,580
450	0·011,100	6 465

(c) *Heat of Reaction, Free Energy of Reaction and Entropy in the Dehydrogenation Equilibrium of Paraffin-Olefin Isomers-Diolefin of the Isopentane and* n-*Butane Series*

Employing the results obtained from the study of dehydrogenation equilibrium of the two very important oleffins, butene-1 and 3-methyl-butene-1 to the corresponding diolefins, butadiene 1, 3 and isoprene in conjunction with the accurate data on the heats of formation obtained by Rossini,[1] heats of hydrogenation obtained by Kistiakowsky,[2] entropy and free energy functions calculated by Pitzer[3] by statistical method and specific heat data given by Beeck[4] the various thermodynamic functions involved in the dehydrogenation equilibrium of Paraffin-Oleffinisomers-Diolefin of the n-Butane and Isopentane series have been calculated. A summary of the more important derivations are given in Table III.

TABLE III

Reactions	Equations for standard Free energies of the reactions	$\Delta H°_{298}$ cals	$\Delta F°_{298}$ cals.	$\Delta S°_{298}$ E.U.	T°₀C.
n-Butane ⇆ Butene-1 + H_2	$\Delta F_T = 28{,}252 + X^* + 12{\cdot}21T$	30,098	20,442	32·4	656
n-Butane ⇆ *cis* Butene-2 + H_2	$\Delta F_T = 26{,}481 + X + 14{\cdot}01T$	28,327	19,207	30·6	653
n-Butane ⇆ *trans* Butene-2 + H_2	$\Delta F_T = 25{,}531 + X + 14{\cdot}\ 6T$	27,377	18,437	30·0	640
Butene-1 ⇆ Butadiene-1 3 + H_2	$\Delta F_T = 25{,}496 + X + 20{\cdot}03T$	27,342	20,015	24·6	744
Cis Butene-2 ⇆ Butadiene-1,3 + H_2	$\Delta F_T = 27{,}267 + X + 18{\cdot}25T$	29,113	21,255	26·5	
Trans Butene-2 ⇆ Butadiene-1,3 + H_2	$\Delta F_T = 28{,}259 + X + 17{\cdot}\ 5T$	30,105	22,025	27·1	
Isopentane ⇆ 3-Methyl-Butene-1 + H_2	$\Delta F_T = 28{,}247 + X + 15{\cdot}12T$	30,093	21,303	29·5	743
Isopentane ⇆ 2-Methyl-Butene-1 + H_2	$\Delta F_T = 26{,}401 + X + 15{\cdot}12T$	28,247	19,457	29·5	685
Isopentane ⇆ 2-Methyl-Butene-2 + H_2	$\Delta F_T = 24{,}830 + X + 16{\cdot}91T$	26,676	18,422	27·7	690
3-Methyl-butene-1 ⇆ Isoprene + H_2	$\Delta F_T = 23{,}884 + X + 19{\cdot}44T$	25,750	18,228	25·2	672
2-Methyl-butene-1 ⇆ Isoprene + H_2	$\Delta F_T = 25{,}750 + X + 19{\cdot}37T$	27,596	20,074	25·2	
2-Methyl-butene-2 ⇆ Isoprene + H_2	$\Delta F_T = 27{,}321 + X + 17{\cdot}53T$	29,167	21,095	27·1	

$* \; X = -6{\cdot}86T\ln T + 0{\cdot}0023T^2 - 10^{-7}T^3.$

Dept. of General Chemistry,
Indian Institute of Science,
Bangalore,
May 23, 1945.

J. C. GHOSH.
A. N. ROY.

1. Rossini, *Chem. Rev.*, 1940 **27**, 1. 2. Kistiakowshy, Ruhoff, Smith and Vaughan, *Jour Amer. Chem. Soc.*, 1936, **58**, 137, *Ibid.*, 1935, **57**, 876. 3 Pitzer, *J. Chem Phy.*, 1937, **5**, 473; *Chem. Rev.* 1940, **27**, 39 4. Beeck, *J. Chem. Phy.*, 1936, **4**, 680.

REVIEWS

Radio Receivers and Transmitters. By S. W. Amos and F. W. Kellaway. (Chapman and Hall, Ltd., 11, Henrietta St., London), 1944. Pp. x + 281 with 150 figures and 8 plates. Price 21 *sh.* net.

There is certainly a real need for a competent book dealing specifically with the various aspects of the design, construction and operation of modern radio receivers and transmitters used for the different types of radio communication. But the volume under review is not, as its title would lead one to expect, such a book. In any case, this subject has developed so greatly that it would be impossible to deal with it satisfactorily within 300 pages, the size of the present book, which is essentially a text-book on the general principles of radio engineering. The title of the book is, therefore, not quite appropriate to its contents. As the authors say, it is not meant for the beginner, but for th esomewhat more advanced student.

The ground covered here is not greatly different from that of the usual text-books Starting with an introduction to the basic ideas and expressions, such as the nature of radio waves, amplitude and frequency modulation, etc., the authors go on to a discussion of the elementary electric circuits and their properties. In Chapter V, five pages out of the eighteen are devoted to radio wave propagation and the rest to receiving and transmitting aerials, mostly for short-wave working Vacuum tubes and their uses, audio and radio frequency amplifiers and their classification into A, B and C types are dealt with in chapters VI, VII and VIII. Chapters VIII and IX cover receivers for amplitude and frequency modulation. The last chapter is devoted to transmitters for telegraphy, amplitude and frequency modulation broadcasting and television. The appendices at the end of the book deal with some of the familiar expressions relating to radio circuits.

The arrangement of the various topics and their treatment leave something to be desired The discussion on vacuum tube theory is rather superficial and spread about. Microphones get about a page and that in the chapter on transmitters in between class B radio amplifiers and transmission lines. Quartz crystals cover about 2 pages. The explanations are in many cases not accurate. A few examples taken at random are the sections dealing with vacuum tubes, wave propagation (Chap. V), quartz crystals (Chap. X), and transmission lines (Chap. X). The discussion on transmitters in the last chapter is sketchy.

A careful revision and rearrangement of the book will enhance the value of a second edition. It may perhaps be better to avoid such expressions as "up in the air" (p. 201). Also "grid base" on page 185 should be "grid bias"

A feature of the book which is worthy of attention is the mathematical discussion of circuits and circuit behaviour. This is invariably good and helps a clear understanding of the problem under discussion. The authors are to be congratulated on this.

The printing and get-up of the book as also the figures and photographs are of the usual high standard for which the publishers are well known. The price is rather on the high side, but this is perhaps due to the prevailing war conditions.

K. SREENIVASAN.

Radio Technique. By A. G. Mills. (Chapman and Hall, 11, Henrietta Street, London, W.C. 2), 1944. Pp. vii+170 with 301 figures. Price 12*s.* 6*d.* net.

This is one of the best books on radio engineering designed for the beginner and the author must be congratulated on it. It is brief, nonmathematical, terse and accurately written. The average legnth of a chapter is a little over 7 pages. The longest covers 22 pages and the shortest but 2 pages. In less than 170 pages, the author attempts to cover a very wide field, starting from the elements of the structure of matter, electricity and magnetism, through d.c. and a.c. machinery and measuring instruments, on to radio transmitters and receivers and even such a comparatively new subject as pulse generators, which have been developed and applied so extensively during this war. That his attempt has achieved this measure of success is because the author chooses his subjects carefully, sticks to a treatment of the essential principles, and is terse in his explanations without sacrificing accuracy and clarity. He knows his subject and can present it well. The reader has necessarily to go to other books for a more detailed and mathematical treatment. But to the beginner, the book can be recommended without reserve.

A chapter on frequency modulation and another on ultra-high frequency and microwave technique would have added to the value of the book. Perhaps this will be made good in the second edition. The book is free from errors, but the half waves in the damped wave train in Fig. 50 (p. 35) should be spaced equally; the frequency of damped oscillations does not change from cycle to cycle or over a cycle. The title of Chapter XIII may perhaps be changed to read "The valve as an oscillation generator".

Praise is due to Messrs. Chapman and Hall for the excellent production of the book. It adds to their reputation as publishers of technical literature.

K. SREENIVASAN.

Hydro-Electric Power in India—A Geographical Analysis. By George Kuriyan. (The Indian Geography Society, Madras), 1945. Pp. 72. Price Rs. 2.

The booklet is the first of a series of Monographs published by the Indian Geographical Society, Madras, and compiles in a very interesting manner a good deal of information regarding water-power resources scattered in various reports published by the Provincial

Governments and by experts like Mr. Meares, Sir William Stampe, Sir Henry Howard and others.

The greatest need of the moment in India is the development of industries and power development is the *sine qua non* for industrialisation. The authors of the Bombay Plan have, therefore, rightly placed the production of power first in the list of basic industries. Unfortunately, as compared with other countries, India is severely handicapped with regard to natural supplies of coal and oil. Besides, as coal is absolutely essential for some of the basic industries such as iron and steel, cement, etc., it is imperative that every effort should be made to conserve our extremely meagre reserves, rather than utilize the same for the production of power. So that in India all developments of power will have to be mainly hydro-electric.

Fortunately, the potential water-power resources of India are indeed very great. On the basis of the Meares Triennial Report of 1922, our resources, even on the most conservative estimates, are about 12 million KW. But the developed resources so far constitute only 6 to 7 per cent. of the potential. The Bombay Plan suggests that the potential reserves are even as high as 27 million KW. Thus there is great scope for development.

The author, after first referring to the most salient geographical and economic features of some of the major hydro-electric schemes now in existence such as the Cauvery and Jog power schemes in Mysore, the three Tata schemes in Bombay, Pykara, Mettur and Papanasam in Madras, Pallivasal in Travancore, Mandi scheme in Punjab, the Ganges Canal Grid in the U.P. and Malakhand in the N.W.F., discusses very briefly some of the important potential reserves which lend themselves to immediate development. The following are some of the important schemes suggested as feasible for immediate development: KOYNA and KOLHAPUR projects in Bombay; MOYYAR and PERIYAR projects in Madras; TUNGABHADRA, GODAVARI and KRISHNA projects (irrigation and hydro-ellectric) in Madras conjointly with Hyderabad; MACHAND project in Madras conjointly with Orissa; JUMNA and SUTLEJ valley schemes in the North; DAMODAR valley, HUKONG valley and TISTA projects in the North-East. These alone would amount to about 3 million KW even on a very conservative estimate, and further expansion could be easily made as the demand for power increases.

The Indian Geographical Society, Madras, and the author, its Hon. Secretary, are to be congratulated in bringing out this useful and informative pamphlet at a time when India is about to enter upon a period of planned development. H. N. RAMACHANDRA RAO.

Colorimetric Determination of Traces of Metals. By E. B. Sandell, (Interscience Publishers, Inc., New York), 1944. Pp. 16 *plus* 487. Price $7.00.

The functional role of traces of metal is one of profound significance in several fields of pure and applied sciences. In the domain of biochemistry traces of iron, copper, manganese, magnesium, zinc and other metals influence the course of physiological reactions; some of them in fact constitute the prosthetic group of certain enzymes essential to their activity. In metallurgy, traces of metals like vanadium, molybdenum and tungsten influence the structure, mechanical strength and corrosion resistance of metals, especially those of steel. The influence of traces of metals on the growth and disease of resistance of plants is well known. These effects are controlled by the concentration of these trace constituents. A colorimetric determination of these important metals in traces when they occur in association with overwhelming quantities of other interfering materials is the problem which the author has lucidly set forth in the volume under review.

The book is divided into two parts: (1) The General Part comprises the principles and the scope of trace analysis, the methods of separation and isolation of the trace elements and the application of colorimetry and spectrophotometry including fluorimetry to the detection and estimation of the trace elements. This part also includes a discussion of the principal organic and inorganic reagents employed in this analytical field. The stability and the range of sensitivity of these reagents are given. (2) The second part deals with the analysis of individual elements; the presentation follows a certain pattern. To quote the author, "First the separation of the metal in question from other elements is considered, chief attention being given so far as possible to those likely to interfere in the colorimetric determination and to those frequently associated with the metal in question. For many metals, methods worked out specifically for the separation of traces are lacking and a brief general outline of separations is all that can be given, with the hope that some of these separations can be extended with suitable modifications to work involving small quantities. Next the important methods of determination are described. The procedures are given in general form so far as possible, independent of the nature of the original sample. The effect of foreign elements, so far as known, is mentioned. Finally, for many of the more important trace elements, directions are given for the determination of the metal in important classes of material". The volume is complete with examples of standard curves indicating the sensitivity and reproducibility of the method. The metals are arranged in the alphabetical order; this facilitates ready reference. An author and subject index completes the volume. The get-up is excellent in spite of war-time restrictions. This is an indispensable volume for not only to analytical chemists, metallurgists and biochemists, but also to the specialist interested in the elucidation of the catalytic role played by trace elements in plant and animal physiology. It is earnestly to be hoped that the author will in due course present to the scientific world an equally useful companion volume pertaining to the colorimetric analysis of non-metals.

Twenty Questions about Russia. By H. W. Henderson. (Hamara Hindustan Publications, Bombay), 1945. Pp. 56. Price As. 8.

Freedom of speech, of the press, of assembly, of street processions and demonstrations, in fact freedom in any form does not exist in the Soviet Union. Communists recognise the right to lie and cheat for the purpose of advancing their cause, the standard of living of the Russian worker was better under the Tsarist system than at present under the Soviet, inequalities exist as under the capitalistic system, Russian industry is run by a well paid bureacracy and the workers have less control over industry in Russia than in any other country in the world, in fact in the Soviet Union the regime is patently a dictatorship OVER the proletariat, and not OF the proletariat.

These are some of the answers of Mr. Henderson—the author of *Twenty Questions about Russia*. As the Webbs have so aptly said in their well-known book on Russia, few other subjects in the history of human civilization have invited such bitter antagonists or ardent admirers as the "New Civilization" which the Comunist Party in Russia have been trying to develop in that vast country since the revolution in 1917. To assess the true value of this great experiment and its phenomenal development in the Soviet Union, one need neither go to bitter critics, to which class Mr. Henderson evidently belongs, nor to ardent admirers and blind enthusiasts. The monumental work of Sydney and Beatrice Webb, *Soviet Communism—A New Civilization*, which is at once accepted as an authoritative and scientific exposition of the working and achievements of the Soviet new institutions would serve much to furnish a comprehensive and dispassionate view of the Russian achievements. But passages from old articles and questionable sources picked at random without any reference to the subject as a whole, as evidently the pamphlet of the type under review can at best be, is injurious to the judgment of people who have either no inclination or no opportunity to go deep into the subject. Reactionary pamphlets of this type and organizations who publish them, ill-serve the people—the villagers of India—whom they ostensibly wish to 'enlighten'.

M. S. MUTHANA.

THE RIDDLE OF LIFE*

IN this little book based on a course of lectures given at Dublin, the author, Nobel Prize winner for Physics, and famous for his contributions to atomic dynamics, has ventured into the field of biology with the hope of throwing some light on the greatest of all problems confronting science—the ultimate nature of life. In these days of excessive specialisation, it requires no little courage for a physicist to venture outside his own field and put forward his ideas on other subjects. Professor Schrödinger is, however, not a specialist of the conventional type. Besides being a mathematician and a physicist, he is also a philosopher, with an original and distinctive outlook on the fundamental problems of science. Anything he says or writes can naturally, therefore, claim the attention and interest of all thoughtful persons.

During the present century, great advances have been made towards an understanding of atomic and molecular structure, and towards an elucidation of the manner in which atoms and molecules join up to form the aggregations familiar to us as various forms of matter. Our ideas regarding the building up of atoms and molecules from the elementary particles of Nature are based on the principles known comprehensively as the "quantum theory". It is the quantum theory which enables us to understand why atoms and molecules have a stable structure, and why, again, a crystal when formed possess an inherent stability and a definite temperature of melting or transformation.

Professor Schrödinger's main idea set out in these lectures appears to be that the quantum theory may also furnish us with the key to the riddle of life. One of the most remarkable features of life at all its levels is its inherent stability, as shown by the permanence of the characters exhibited by a species when it reproduces itself from generation to generation. Modern biological research has established the intimate relationship between this inherent stability and the ultimate structure of the living cell, and especially of the parts of it known as the chromosomes. It has also established the fact that changes in these structures accompany a mutation of the species either occurring naturally or when artificially induced. These facts become intelligible if we regard the genes as distinct molecular species which can only be altered by "quantum jumps".

Professor Schrödinger has also some interesting suggestions to offer regarding the relation between the fundamental principles of thermodynamics, and the processes by which life functions, including especially the consumption and assimilation of food.

The book is both an attractive and a stimulating production.

C. V. RAMAN.

* *What is Life?* by Erwin Schrodinger, pp. viii + 91, 6 *sh.* net, Cambridge University Press.

THE ACADEMY OF SCIENCES, U.S.S.R.

The Academy of Sciences of the U.S.S.R. is holding the celebration of its 220th anniversary from the 15th to the 28th of June 1945. Invitations have been extended to the foremost scientists in all allied countries. Professor Meghnad Saha, F.R.S., according to Reuter, has safely arrived in Moscow to participate in the celebrations.

SCIENCE NOTES AND NEWS

The Trustees of the Lady Tata Memorial Trust announce on the death anniversary of Lady Tata, which falls on the 18th June, the awards of the following scholarships and grants for the year 1945-46:—

I. International Awards for research in diseases of the blood with special reference to Leucœmias:

(1) Dr. P. A. Gorer, London—Grant £70; (2) Dr. A. H. T. Robb-Smith, London—Grant £100; (3) Dr. Werner Jacobson, Cambridge—Grant £300; (4) Dr. (Miss) P. Hammick (to work under Prof. Witts to confirm Dr. Jacobson's research)—Grant £400.

II. Indian Scholarships of Rs. 150 per month each for one year from 1st July 1945 for scientific investigations having a bearing on the alleviation of human suffering:—

(1) Mrs. Alamela Venkataraman, B.A., M.SC. "Synthesis of Sulphanilamide Derivatives." (Haffkine Institute, Bombay.) (2) Mr. S. Dattatreya Rao, B.SC. (HONS.). "Investigations on the Synergy between Vitamins A and E and Functions of Carotene and Vitamin A in the Animal System." (Indian Institute of Science, Bangalore.) (3) Mr. L. D. Sanghvi, B.SC. (First Class), M.SC. "Genetical Study of Blood Groups and Diseases with Special Reference to Malignant Tumours and Erythroblastosis Fœtalis in Bombay." (Tata Memorial Hospital, Bombay.) (4) Mr. T. A. Venkitasubramanian, B.SC. "Synthesis of Anti-parasitic Agents against Tropical Diseases other than Malaria with Special Reference to Amædines and Organometallic Compounds." (Maharaja's College, Ernakulam.) (5) Mr. G. Balasubramanyam, M.SC. (First Class). "Insulin Derivatives and Carbohydrate Metabolism." (Indian Institute of Science, Bangalore.) (6) Mr. T. K. Wadhwani, B.Pharm. "Mechanism of the mottling of teeth." (Indian Institute of Science, Bangalore.) (7) Mr. Rabindra Kumar Basu, M.SC. "Synthesis of Vitamin C (1-Ascorbic Acid)." (University College of Science and Technology, Calcutta.) (8) Mr. Kalipada Mukherjee, M.SC. "Research on Food Yeast." (Biochemical Laboratories, University of Dacca, Dacca.)

The first annual sessions of the Ceylon Association of Science, inaugurated in July last year, was held in the University Hall, Colombo, from May 17th to 19th and was largely attended by all leading scientists in the Island.

The General President, Dr. D. N. Wadia, former Government Mineralogist, Ceylon, and now Mineral Adviser, Department of Planning and Development, New Delhi, was unavoidably absent and his presidential address on "Science in Ceylon's National Life", was read by the President-elect, Prof. W. A. E. Karunaratne.

In a message sent to the Annual Sessions, H. E. the Governor stressed the Contribution of Science to World Peace and wished all success to the Association.

The sessions was declared open by Mr. C. W. W. Kannangara, the Minister of Education and Pro-Chancellor of the Ceylon University. This was followed by a symposium on "Science and National Development", initiated by Dr. Andreas Nell.

As in India, Science Congress Sessions sectional or intersectional meetings were held in the mornings and visits were arranged to centres of scientific interest in Colombo in the afternoons. The last item of the programme each day was a popular lecture.

Prof. A. Kandiah, Acting Vice-Chancellor, University of Ceylon, was elected President and Prof. W. A. E. Karunaratne, the new General President.

The decision of the University of Aberdeen to confer an honorary degree of Doctor of Laws (LL.D.) upon Mr. Stanley Unwin, the publisher, sets an interesting precedent. On the Continent, it has long been the practice of Universities to encourage outstanding work by publishers in the interests of scholarship. But if one excludes those occasions when a University has recognised in this way someone connected with its own Press, this represents, we believe, the first time a publisher has been so honoured in Great Britain. It is pleasing evidence of that improved status of books, which Mr. Unwin has himself done so much to achieve Mr. Stanley Unwin is the owner of the firm of George Allen & Unwin Ltd., Chairman of John Lane, the Bodley Head Ltd., and a director of Methuen & Co., Ltd. He is a past President of both the Publishers' Association of Great Britain and of the International Publishers' Congress and comes from a family long connected with printing and publishing. As President of the International Publishers' Congress in 1936 it was his duty to present the principal foreign delegates to King Edward VIII at Buckingham Palace.

SEISMOLOGICAL NOTES

Among the earthquake shocks recorded by the seismographs in the Colaba Observatory, Bombay, during the month of May 1945, there were two of slight intensity. The details for those shocks are given in the following table:

Date	Time of origin I.S.T.	Epicentral distance from Bombay	Co-ordinates of epicentre	Remarks
	H. M.	(Miles)		
9	10 05	2410	..	Probably deep.
19	11 33	1310	..	Epc: In Assam.

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CURRENT SCIENCE

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A DECIMAL COINAGE SYSTEM FOR INDIA

THE Government of India have recently circularised, for the purpose of eliciting public opinion, the outlines of a plan to decimalise the coinage of the country. The plan, in brief, is to divide the existing rupee into 100 cents. The present one-rupee, half-rupee and quarter-rupee coins would continue to be minted in their existing size, shape, weight and metal content; only the half-rupee would be designated 50 cents and the quarter rupee as 25 cents. Coins of lower denominations are proposed to be replaced, under the new system, by 10, 5, 2, 1 and perhaps also ½ cent coins. The two sets of coins would naturally have to circulate and will be freely interchangeable during a transition period in the course of which there will be no fresh minting of the annas and pies and their gradual withdrawal leading to the eventual and complete elimination of these coins.

Any change in the coinage system of a country is a serious matter affecting as it does the daily life of the individual and of the community at almost innumerable points. Government would, as is easily understandable, be reluctant to sponsor any reform with such profound and far-flung consequences unless they be assured of at least a certain modicum of public support. Government are now engaged in ascertaining the extent of such support. We are not, however, aware of any special measures adopted by Government to consult men of science and organised scientific opinion. But, these latter are as much interested, to put it no higher, in such a proposal as other sections of the community. For, decimalisation of coinage—quite apart from its being desirable in itself—is an important precedent to and in some ways a powerful lever for similar transformation in the weights and measures employed by the community and these in their turn, pave the way to a completely rationalised system of the expression of all quantitative values in decimalised units. A decimalised system is a *scientific* system.

The case against the proposed change may first be summarised. It will involve the adaptation of the entire price, wage and rate structure of the community—changes which necessitate a colossal amount of extra work and will also, let it be admitted and faced, lead to inevitable friction, misunderstanding and even fraud in the earlier stages. Certain subsidiary changes will also be forced on the community which, again, will have to pay for it in the long run—such, for example, as the adaptation of rail-tickets, postage stamps, automats, actuated by coins, to name a few. The change will provide a wide and fertile field for the unsocial elements of the community to exploit large masses of the uninformed, the illiterate and the gullible. This can never be prevented although much could be done (and the Government propose to take special measures on this behalf should the new coinage be decided upon) to minimise the evil. There is also the element of sentiment and tradition—imponderable but nonetheless very real factors to contend with—which in this country are exceptionally strong. This conservatism would of course not take kindly to any innovation in coinage and might put in obstacles in many unexpected ways whose net effect would be to slightly depreciate the new coins against those which are to be replaced.

On the other hand, the case for the change is necessarily based on a long-term assessment of the accruing advantages. The first and foremost of these is the enormous simplification and saving in time which the new system would ensure in calculations and accounting. The money value of this saving in time and effort would be the equivalent of lakhs of rupees annually to industry and commerce alone. As for the educational value of the proposed change, it would be a veritable boon to children of the school-going ages,

It may at once be said that the lessening of the strain involved in memorising and inter-relating to the rupee-annas-pies trinity by the elementary school-going children alone would be worth and more than worth all the expense and trouble involved in the change-over. Next to the burden of learning his lessons through a medium other than his mother-tongue, one of the most serious handicaps to the unfortunate Indian student of tender years is the bugbear of manipulating "Tables"—arbitrary units of money, weights and measures. It is a tragic waste of effort. And viewed from this angle, a decimal coinage system would constitute a great gift of the present generation to posterity—especially to the generations of students yet to come. Amongst much less important advantages, mention may be made of the fact that the most modern accounting and computing machines are designed to be adaptable to the decimal system and a country which clings to outworn arbitrary systems perforce will deny itself these aids of the modern business world. All things considered, the advantages of decimalised coinage are so overwhelming that many of the countries even in the slow-to-change Orient have switched over to decimal coinage. Malaya, Netherlands, Iraq, Palestine and Thailand all have decimal coinage. India's close neighbour, Ceylon, has her rupee divided into 100 cents. In Europe, Great Britain is the only important country not to have decimal coinage. Indeed, in the whole world, it is only parts of the British Empire that form the most notable exceptions to the tendency of all progressive nations adopting the decimal system of coinage.

Now, the point to remember is that these countries in changing over from their outmoded systems to the decimal system knew and did pay the cost involved and inseparable from such a change. Some of these countries had to contend with obstacles similar to Indian conditions. Thus Russia who completed her decimal coinage transformation in 1897 had to reckon with masses of a predominantly agricultural population—mostly illiterate—spread over vast areas not well-served with transport. But, the new system was introduced. To repeat, the price of the change is high but the charge is worth the price. In this connection, it is interesting to recall that a proposal was afoot just before the present war that the right angle be divided into 100 degrees. It was conceded by the sponsors that the task of re-computing mariners' charts and tables alone on the new division would be a stupendous task but the advocates of the proposal were definitely of the opinion that this difficulty was not insuperable and must be squarely faced. The question could not, however, be considered fully on its merits owing to the war intervening. It is mentioned here just to indicate the trend of progressive world opinion in such matters.

While the difficulties are there, India at present will enjoy certain advantages which makes the change-over—should it be decided upon—about the least painful. The chief of these is the fact that quite apart from any change in the coinage system, the Government have a programme, in the post-war period, of large re-coinage operations. Owing, partly to the increase in currency circulation and partly due to the necessity of conserving critical metal supplies, the Indian mints put in circulation during the war large numbers of coins of altered format and alloy-content which are not exactly popular. Also, the circulation of nickel alloys had been strictly regulated. It is, however, the view of coinage experts that cupro-nickel alloys are preferable for coinage to the bronze alloys in India where the common use of brass for domestic utensils lends bronze coins to easier counterfeiting. For these and other reasons, there will be a large re-coinage programme in Indian mints immediately after the war when nickel is not subject to wartime rationing. An excellent opportunity will thus be presented to issue decimal coinage without undue expense being incurred solely for this purpose. Other favourable factors in India in the immediate future are, that a period of contracting currency is better for an innovation of this kind than an inflationary period. Also, an increase in the standard of living which all post-war planning is dedicated will render smoother the acceptance of the proposed one cent (1/100 of the rupee) as the smallest coin (should the ½ cent coin be not issued in the new scheme) in the land in place of the existing one pie ($^1/_{192}$ of the rupee) which at the present level of prices has already very largely ceased to play a role in the daily transactions of the community. Still another helpful factor would be that the National War Front and allied quasi-official organisations which have been built up for war purposes could well be utilised in explaining, again without extra expense on this account, and familiarising the new coinage to the people in every nook and corner of the country thus neutralising to some extent at least the victimisation of the ignorant.

Finally, it has to be remembered that for sweeping changes of this kind, in a country like India (for that matter, only perhaps not to the same extent, in *any* country), a slight element of compulsion—a gentle "leading in by the nose"—would seem to be nearly indispensable. The change-over to "Summer Time" in European countries is a case in point. All kinds of dire calamities were freely prophesied in the early stages when the innovation was first made but people gradually reconciled themselves and then began to appreciate the rationale and convenience of adjusting their clocks to practical needs every winter and summer. In our own country, the furore which the advancing of the Indian clock, in 1942 raised is nearly forgotten now. It is safe to presume a similar adjustment of the community to a change in its coinage. Only, the period of readjustment may take longer. One should prepare for its being so in a predominantly agricultural country like India where exotic practices are sanctified to a stage when their essential irrationale is masked by the veneer of usage and convention. (Such for example are the hours during which Indian offices and schools work; why, even the hours of play often!). The present coinage system is one of these anachronisms—only much bigger in magnitude and more ramified in its effects. Its replacement by a rational system of coinage does involve heavy sacrifices on

the present generation. But, the change is well worth the price and the price to be paid will be at about its minimum in the immediate post-war period. Such an opportunity may not recur for a very long time to come. Now, therefore, is the time to introduce a decimal coinage system in India.

INDIAN INDUSTRIALISTS' DELEGATION IN THE UNITED KINGDOM

A DELEGATION of Indian industrialists, led by Mr. G. D. Birla and Mr. J. R. D. Tata, have just completed a tour of the United Kingdom and are at present in the United States. The objects of these visits are broadly stated to be to explore the possibility, extent and terms on which the co-operation and assistance of British and American Industry could be had in the post-war development of Indian industry.

The influential membership of the delegation, the importance to the country of the subjects they were handling and the elaborate preparatory work for their reception and programme abroad all served to focus public attention in this mission which, however, had had even more than its normal share of spotlight thrown on it due to some critical comments from Mahatma Gandhi. This opportunity was availed of by the members of the delegation in reiterating what they had already stated publicly and unambiguously on the status and scope of the mission. The industrialists were going abroad as private individuals at their own expense and on their own responsibility with no commission or intention of committing any one excepting themselves in their negotiations abroad.

Messages in the daily press have given accounts of the cordiality with which the members have been received and the numerous industrial and technical establishments through which they have been conducted. The press has also recorded the conclusion of some definite agreements as for example, a co-operative enterprise between the Birla and Nuffield interests to start a factory in India, to begin assemblage and ultimately manufacture Morris Cars in India. The following message from the London correspondent of the *Capital* to his paper on the eve of the delegation's departure to the United States well summarises the work of the delegation; says the correspondent, "The Indian industrialists who have been visiting us, are on the verge of departure for the United States. They beam with happiness. They have seen as many of our great industrial works, and as much of them, as they desired .... All this is not saying that no questions of importance, or anxiety, remain unsolved or are still rather perplexing .... The mutual changes of outlook are expressed in some pretty important, newly negotiated, contracts. How many is not to be said here. One seems always hearing something fresh in that line ....."

Apart from these and similar agreements which individual members might have concluded on behalf of the interests they represent, the visit of the delegation seems to have been productive of results of a larger order benefiting the country as a whole. There was an impression abroad, by no means uncommon, that the Indian businessman was usually a "merchant"—a sort of glorifical agent who "represented", for a commission, the foreign manufacturer. While the merchant does continue to play his useful and honourable role in the country even now, it is not appreciated adequately abroad that the Indian businessman to-day is also a progressive and enlightened *manufacturer*—investing capital with its attendant risks, producing goods with the requisite competitive skill, handling labour with its attendant problems and selling them in the open market on his own account *and* making a profit. Thus, for example, the outstanding fact that one of the largest Iron and Steel plants in the British Empire, is owned and operated by Indians at Jamshedpur is often missed, at least by implication, by many. And quite a few industrialists should have been surprised that the Indian visitors could hold their own in any parleys regarding their particular industry, both in the technical and organisational aspects. And it is on such mutual knowledge that respect and appreciation of the various interests involved are born, and it is on these, in turn, that any stable business relationship can be built. There could be no doubt that the visit of the Indian Industrial Delegation has helped to foster such relationship.

Secondly, the activities of the delegation have made a definite contribution to the more widespread realisation in Britain that the industrial prosperity in India need not be at the expense of any other country. Lord Nuffield has recently given eloquent expression to such sentiment, as follows: "There are people who would lament that this progressive industrialisation of the Empire means a concomitant decline in British Exports. I absolutely disagree. Indeed, I contend that the contrary will be the case. The more Indians who exchange the pittance from the paddy fields for the higher wages of the Motor Car assembly factory and the more Indians who ride in motor cars, bringing the inevitable opening up of new roads and trades in the backward villages, the more tremendous will be India's demands for all manner of British exports goods that in the bad old days of muddy lanes and bullock carts, the bulk of her people could never afford."

In wishing the delegation a pleasant and useful sojourn in the United States also, *Current Science* hopes that these unofficial ambassadors of Indian Industry will not have failed to notice the generous and extensive manner in which industry in these foreign countries have nourished and sustained scientific research from which in turn, industry derives its strength and competitive position. Such appreciation and its translation to action in India might well prove to be the most fruitful by-product of these tours of the delegation abroad.

A LINEAR TIME INTERVAL METER

By N. B. BHATT, Sc.D.

(Department of Electrical Technology, Indian Institute of Science, Bangalore)

THE change of voltage developed across the plates of a condenser which is either being charged by a steady source of potential E_0 in series with a resistance or discharged through a resistance, is extensively used as a measure of the time interval during which either process has taken place. The basis of this is the well-known relationship which, however, gives the voltage across the condenser as an exponential function of time. Various devices have, therefore, been employed to obtain linearisation of the voltage-time relationship since the R C circuit forms a very convenient time base in Cathode-Ray Oscillographs. In a recent publication Puckle[1] has given a detailed account of several such circuit arrangements.

Walker[2] has described an instrument for measuring short intervals of time wherein he has assumed the essential linearity of the voltage-time characteristics during the first 5 per cent. rise of the total voltage E_0 across the plates. The voltage-efficiency of such a charging circuit is quite poor inasmuch as 95 per cent. of the supply voltage stands idle except for its contribution towards the initial linearity. The so-called "Constant Current" charging circuit employs a pentode tube operated above the "knee" of its plate current-plate voltage characteristics, in place of the constant resistance element. Such an arrangement approximates fairly to a constant rate of charge and the voltage efficiency of the circuit depends on how high the supply voltage is kept above the "knee" in the pentode characteristics. This device, therefore, necessitates the use of a steady source of the order of a few hundred volts.

The present communication describes a time interval meter employing the ordinary R C circuit the exponential voltage rise across the condenser of which is compensated in the indicating device which is a vacuum tube voltmeter working on the curved portion of its dynamic characteristics. Within the degree of compensation achieved, therefore, the indications of the meter are directly proportional to time. The obvious advantage of this method is that a charging voltage of much smaller magnitude is used and it is found, as will be seen later, that the voltage efficiency is over 55 per cent. with a good degree of linearity provided the value of the charging voltage, the vacuum tube and its asociated circuit are properly chosen. Mention has been made in literature of this "linearisation by the inverse curavture of vacuum tube characteristics;"[3] but so far as the author is aware no detailed investigation has been reported regarding particularly the degree of linearity and the voltage efficiency obtainable in this manner when small charging voltages are used.

Fig. 1 shows the circuit assembly, the timing part of which forms the grid circuit of RCA-1D5GP type tube having remote cut-off characteristics. The two relays S_1 and S_2 mark the beginning and the end respectively of the time interval to be measured. Initially both S_1 and S_2 are closed and the grid of the tube has a large negative bias to give no indication in the plate meter M. At the commencement of the interval S_1 opens up and removes the short circuit of the condenser C which starts to charge up, thus lowering the value of the negative bias on the grid in the process which results in a deflection of M. S_2 opens at the close of the interval and stops

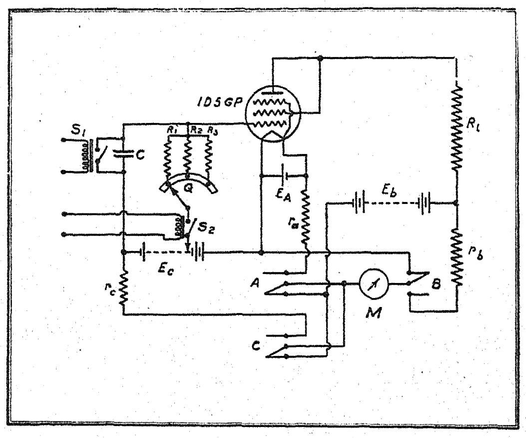

FIG. 1

the charging of C. The indications of M thus obtained are made proportional to time by previously adjusting the charging voltage E_0 in the timing circuit and the initial grid bias, plate voltage E_b and the load resistance R in the vacuum tube circuit. Fig. 2 shows a few of these two sets of characteristics; the dotted curves give the voltage time characteristics for three different values of E_0 and represent solution of the equation

$$E = E_0 (1 - e^{-\frac{t}{CR}}) \qquad (1)$$

for $E_0 = 14^v, 16^v, 18^v$; $C = 0{\cdot}875$ mF; $R = 1{\cdot}57$ meg.

The solid curves in Fig. 2 represent the dynamic characteristics of the vacuum tube 1D5GP for two different values of the load resistance with 80 volts on the plate; these values have been so manipulated that the $i_p - e_g$ curve in the region of interest obeys the following relationship:

$$i_p = Ae^{be_g} \qquad (2)$$

where i_p *is the plate current* in milliamperes, e_g is the grid voltage and the constants A and b are positive numbers. A plot of $ln\ i_p - e_g$ results in a straight line whose slope directly gives b, A being calculated therefrom. It would be true to say that i_p equals A at zero

grid bias voltlage, provided only that the region of the zero grid voltage is included in

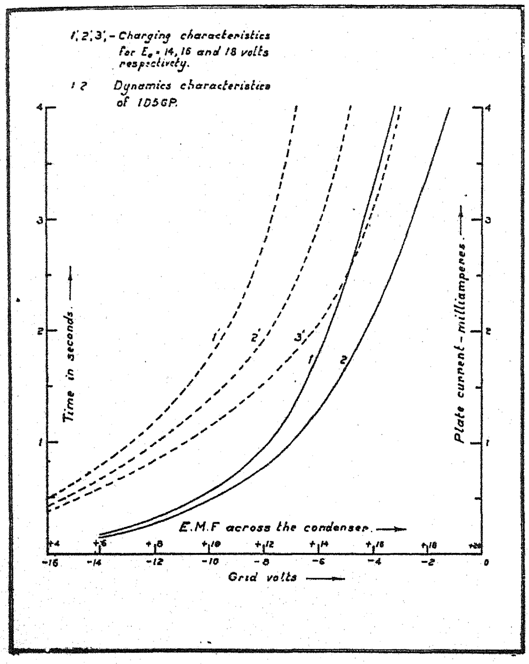

FIG. 2

the validity of equation (2). If not, the experimental value of i_p at $e_g = 0$ will normally not be equal to A.

Both the characteristics are plotted on the same abscissa since by applying Kirchoff's Law to the circuit we get the following equation

$$E_c + e_g - E = 0 \tag{3}$$

where e_g is the net voltage on the grid E that across the condenser C at any time and E_c is the value of the total voltage of the source (this is different from the charging voltage E_0). Therefore, indications given by the meter M in Fig. 1 represent those values of time which intersect the same vertical line corresponding to a definite value of the voltage in Fig. 2. In this manner a plot of $i_p - t$ for a given pair of charging characteristics and $i_p - e_g$ characteristics is obtained and is shown in Fig. 3. It will be seen that this curve is fairly linear over its major portion with sharp curvatures at either ends. The extent of linearity and the slope of the plot thus obtained depend on E_0 on one hand and A and b of the dynamic characteristics on the other. Out of a number of possible combinations it is possible to select one which will give the best compromise between linearity, voltage efficiency and sensitivity. In the present case the charging voltage E is kept at 16 volts and the dynamic characteristic chosen has $A = 11 \cdot 0$ and $b = 0 \cdot 303$. The plate meter has a range of 0-3 ma. and will give a full-scale deflection when t goes to infinity. Under these conditions for a 3 per cent. change

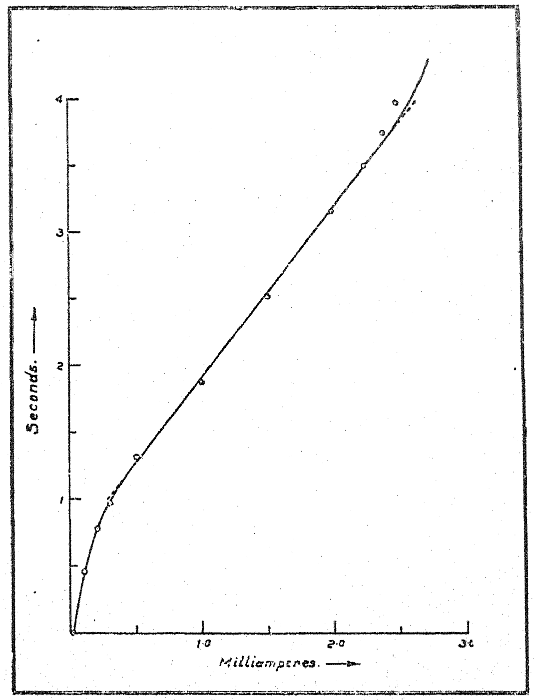

FIG. 3

of linearity the voltage efficiency is over 55 per cent.; and within this degree of linearity the deflections of the meter are non-linear over a total of only 10 per cent. of the scale divisions at both ends as shown in Fig. 4.

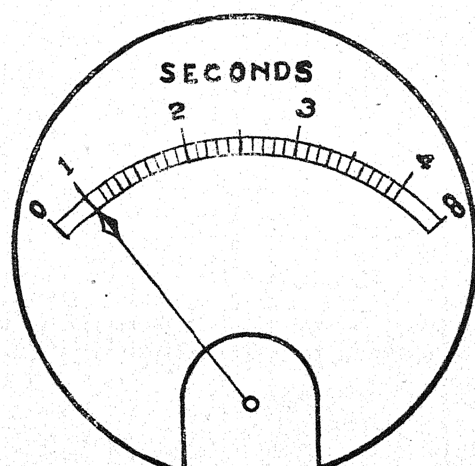

FIG. 4

The selection of a suitable pair of characteristics is much facilitated by an analytical

relationship between i_p and t. Rewriting equations (1) and (2) we get

$$E = E_0\left(1 - e^{-\frac{t}{CR}}\right) \qquad (1)$$

$$e_g = \frac{1}{b}\, ln\, \frac{i_p}{A} \qquad (4)$$

substitution of (1) in (3) gives

$$e_g + E_c = E_0\left(1 - e^{-\frac{t}{CR}}\right) \qquad (5)$$

substituting for e_g in (5) from (4) and solving for t we get

$$t = -RC\, ln\left[K - \frac{1}{bE_0}\, ln\, i_p\right] \qquad (6)$$

$$\text{where } K \equiv 1 + \frac{1}{E_0}\left[\frac{1}{b}\, ln\, A - E_c\right]$$

Inserting the values for E_c, E_0, A and b for the specific case given in Fig. 3, equation (6) reduces to the following form:

$$t = -RC\, ln\, (0{\cdot}244 - 0{\cdot}206\, ln\, i_p) \qquad (7)$$

Points computed from the above relationship have been marked as circles along with the experimental plot in Fig. 3. The divergence of the computed points from the experimental curve for values of i_p above 2·5 ma. is due to its departure from the relationship given by equation (2) in that region; however, this has been advantageous here for extending the region of linearity.

In actual rig-up the instrument employs two identical Western Electric Telephone Relays operating on a current of about 1·0 ma. through the coils energised by external agencies *via* the two pairs of terminals provided. The timing circuit utilises a Western Electric mica condenser and wire-wound resistances whose values are accurately determined. Three such resistances are selected by switch Q for three ranges covering 0·1–4·0 seconds. Inclusion of a further lower range may not be possible due to the finite time lag in the electromagnetic relays used. Great care has to be taken to prevent electrical leakage by mounting all the components of the timing circuits on high insulators; relay contacts should be kept clean and should have a high leakage resistance, an indication of which is the constancy of a reading over comparatively much longer duration. The low filament current (60 ma.) of the tube 1D5GP permits a complete dry battery operation, which, besides making the instrument self-contained, offers steady potentials essential for preserving the calibration. Provision is made to check all the voltage on the meter by pressing the appropriate pushbutton switches A, B and C as shown in Fig. 1.

The instrument has been developed in the laboratory in connection with measurements of sound intensities at various levels during its grow and decay in a reverberation chamber. It will also be found useful in a variety of fields where intervals of time are to be determined with a fair degree of accuracy.

The author is indebted to Mr. B. Subramaniam, B.Sc. (Hons.), for the necessary data embodying Fig. 2.

1. Puckle, O. S., *J.I.E.E.*, 1942, **89**, Part III, 100. (See also *Time Bases*, 1943, Chapman & Hall Ltd.) 2. Walker, E., *Jour. Frank. Inst.*, 1941, **231**, 373. 3 Puckle, O. S., *Loc. cit.*

INFLUENCE OF MERCURY ON INSECT EGGS—PART II

By

B. KRISHNAMURTI AND M. APPANNA

(Entomological Laboratory, Department of Agriculture, Bangalore)

I. Internal changes caused by the penetration of mercury vapour into the eggs

EGGS of *Corcyra cephalonica*, 16-hours old, were exposed, for 48 hours, to the lethal dose of mercury previously determined, in a closed cylindrical jar of known volume. Necessary controls were maintained.

Microtome sections of exposed and sound eggs were examined.

The sections of the sound eggs revealed a normal proliferation of the cells and the formation of the embryo; the differentiation of the midgut and the floating cells within the lumen and the epithelial cells lining the midgut could all be clearly observed (see Fig. 1).

Sections of the exposed eggs showed little definition of the cells; the cytoplasm and nuclei were found in different stages of disintegration. The midgut could not be distinguished nor the epithelial cells. A heavily stained mass of fat, albuminoid and disorganised yolk was seen to fill the entire space (Fig. 2).

A 48-hour period of exposure was adopted since it represents the minimum period of mercury to penetrate and kill the eggs. Ninety-six hours' exposure showed complete destruction of the cellular and nuclear structures. The shrinkage of the disintegrated matter resulted in the formation of a blank cavity. Heavy precipitation was also quite evident.

These observations show that mercury vapour disintegrates the cellular contents and structures either partially or completely depending on the length of exposure.

II. Effect of mercury in grainfilled space

The dosage of 0·03 gm. of mercury effective in 3,300 c.c volume of empty space, did not prove uniformly effective against eggs placed at different points in a similar volume of grainfilled container. Only eggs, kept at a depth of 2·5 cms. below the level of mercury, were killed. Tests were, therefore, conducted with higher weights of mercury to find out the minimum lethal dose for 3,300 c.c. of

grainfilled space. The eggs were placed at the middle and also at the bottom of the grain-filled receptacle; the mercury was placed at the top. The results are given in Table A.

FIG. 1 FIG. 2

1. Longitudinal section of sound egg (nearly 64 hours old showing the normal formation and development of larval embryo.

2. Longitudinal section of affected egg (nearly 64 hours old) showing mostly heavily stained fat and other disorganised materials.

TABLE A

Weight of Mercury	Percentage of Kill
0·03 gm.	Nil.
0·04 ,,	Nil.
0·05 ,,	82
0·06 ,,	100
0·10 ,,	100
0·40 ,,	100

III. Correlation between volumes of empty and grainfilled spaces and the effective lethal doses of mercury

A series of tests were made to determine the lethal doses of mercury for increased volumes of empty and grainfilled spaces. In all the tests, mercury was placed at the top and the eggs at the bottom of the receptacles. Volumes (of empty space) such as 4,000, 6,600, 8,000 and 10,800 c.c., were used (Table B).

TABLE B

Volume	Empty Space		Grainfilled Space	
	Weight of Mercury	Percentage of Kill	Weight of Mercury	Percentage of Kill
4000 c.c	0·05 gm.	100	0·10 gm.	100
6600 ,,	0·06 ,,	100	0·12 ,,	100
8000 ,,	0·10 ,,	100	0·20 ,,	100
10800 ,,	0·18 ,,	100	0·36 ,,	100

Similar volumes of grainfilled space were also taken and different weights of mercury used in each case, in order to fix the effective doses for those volumes. In all these cases, the mercury was placed on the top surface of the grain and the eggs exposed, one lot at the middle and the other at the bottom. It was considered necessary to have this arrangement in these tests, since, in natural storage of grains either in bins or bags, the insect infestation (egg stage especially) is mostly always confined to the surface layers and very rarely extends to the deeper ones; the mercury vapour traversing downwards, would affect the eggs not only in the layers of the grain immediately below the surface but also those in the central and deeper layers, if for some reason (in the case of loosely packed grain for example) eggs get laid even there.

In all these volumes there is seen a gradual increase in the weight of mercury corresponding with the increase in the volumes of both empty and grainfilled spaces.

IV. Correlation between the effective doses of mercury for similar volumes of empty and grainfilled spaces

From Table B it can be seen that the effective dose for any one volume of empty space is about half that for the same volume of grainfilled space. This simple ratio of 1:2 in the case of these particular volumes tested may possibly hold true for still higher volumes of space under similar air-tight conditions.

V. The actual minimum effective (lethal) doses of mercury

It was observed in all the experiments made with the minimum effective doses of mercury for the several volumes of empty and grain-filled spaces, that the mercury did not vapourise completely during the period (the normal period required for unexposed eggs to hatch) it was allowed to act on the eggs, but that a portion of it remained over as solid metal. This residual mercury was weighed in each case and the difference between the weight of the metal originally determined as the minimum effective dose and the residual mercury was noted. The difference proved to be that actual weight of mercury which was definitely used up in the form of vapour during the period of each experiment. This weight of mercury is, therefore, to be considered as the ultimate and actual minimum effective dose as against the original weight which can only be the apparent minimum dose.

It might be mentioned here that though the apparent effective weight of mercury is many times more than the actual effective weight, quantities of mercury less than the minimum apparent effective weight (for a given volume) of mercury were not found to be effective. This may be because of the limiting factor—the normal period of hatching of the eggs (four days)—during which time the vapour pressure inside the container has to attain the optimum to affect the eggs.

One of the aims of these experiments was to see if any definite ratio existed between increasing volumes of empty and grainfilled spaces and respective effective doses of mercury. Referring to the figures in the tables, it is, however, seen that no clear and definite

ratio appears to exist between either the apparent minimum weights of mercuty or the actual minimum weights of mercury with reference to increases in volumes of space. This is probably partly because the increases in volumes of space so far employed in these experiments are so small that the corresponding effective minimum weights differ very little from one another or remain practically the same.

VI. *Effect of actual minimum weight of mercury in the form of amalgam on* Corcyra cephalonica *eggs in a given volume of grainfilled space*

A series of confirmatory tests were made with the actual minimum weights of mercury (as shown in Table C) for given volumes of grainfilled space. Being very small quantities, mercury was spread on copper foils and were kept at the top surface of the grains, the eggs being placed at the bottom. Table D gives the results.

TABLE C

Volume	Empty space			Grainfilled space		
	Apparent effective weight of mercury	Actual effective weight of mercury	Percentage of kill	Apparent effective weight of mercury	Actual effective weight of mercury	Percentage of kill
3300 c.c.	0·0306 gm.	0·0006 gm.	100	0·0600 gm.	0·0006 gm.	100
4000 ,,	0·0508 ,,	0·0007 ,,	100	0·1012 ,,	0·0008 ,,	100
6600 ,,	0·0600 ,,	0·0014 ,,	100	0·1203 ,,	0·0014 ,,	100
8000 ,,	0·1010 ,,	0·0016 ,,	100	0·2008 ,,	0·0016 ,,	100
10800 ,,	0·1800 ,,	0·0024 ,,	100	0·3650 ,,	0·0024 ,,	100

TABLE D

Volume	Actual weight of mercury in amalgam	Percentage of kill
3300 c.c.	0·0006 gms.	100
4000 ,,	0·0009 gms.	100
6600 ,,	0·0014 gms.	100
8000 ,,	0·0016 gms.	100
10800 ,,	0·0026 gms.	100

It could be seen from Table D that the actual minimum weight of mercury for a given volume of enclosed grainfilled space, when used as an amalgam, proved to be effective against the eggs. In all the trials the mercury volatilised completely with slight traces at the sides of the copper foils where mercury was invariably thicker than in the centre. Such residual deposits in majority of the cases weighed not more than 0·0001 gm. each.

ACKNOWLEDGMENT

We are very thankful to the Agricultural Chemist and his assistants, for active help in weighing minute quantities of mercury in the chemical laboratory.

CONCLUSION

From the foregoing observations it may be concluded that:—

1. Mercury vapour penetrating the egg of *Corcyra cephalonica* prevents normal embryonic development by causing a destructive disorganisation and disintegration of the cytoplasmic and nuclear structures of the cells.

2. A simple ratio of 1 : 2 is noted to exist between the minimum effective weights of mercury in certain similar volumes of empty and grainfilled spaces used.

3. No definite ratio is evident between increases in the volumes of empty and grainfilled spaces and the corresponding increases in the minimum effective weights of mercury.

4. The actual minimum effective weight of mercury for any volume of empty or grainfilled space, is only a fraction of the apparent minimum effective weight for that volume.

5. The actual minimum effective weight of mercury for any volume of grainfilled space, if used in the form of an amalgam, is also found to be effective against the eggs.

GEOPHYSICAL PROSPECTING

GEOPHYSICAL methods of prospecting mineral ores and oil resources have assumed great practical importance in U.K. and U.S.A., particularly in the latter country, and spectacular results have been obtained through the application of these methods. Instances of large-scale mapping of ore beds in India, by the application of geophysical methods are few, and for this reason, the results obtained by a party of the Survey of India on the manganese beds in Parsoda area (C.P.) by the use of the gradiometer, reported in the latest issue of the *Journal of Scientific and Industrial Research*, are of more than usual interest. In the area surveyed, a manganese reef has been successfully located. The pattern of the profiles, and the magnitude and depth of the sub-surface bodies, have been determined. In alluvial areas of the type surveyed, where no outcrops are available to indicate what is below, geophysical methods are of particular value. They provide valuable preliminary indications and save the expense of sinking random pits. Definite information regarding configuration and depth of the sub-surface body can be obtained by one or two borings.

CENTRAL ELECTRICAL RESEARCH BOARD

THE greatest need of the moment in India is the development of industries and power development in the *sine qua non* for industrialisation. Though some strides in this direction have already been made in recent years, very much more remains to be done. Though India is not favourably placed with regard to the natural supplies of coal and oil, the potential water power resources are indeed very great. On the basis of the Meares Triennial Report, our resources even on the most conservative estimates are about 12 million kw. But the developed resources so far constitute only 6 to 7 per cent. of this potential. Thus in the post-war period attention will have to be first concentrated on the production of power.

In India electric power development would mainly be in the hands of the several Provincial Governments and Governments of Indian States. Further for some of the schemes, such as the Tungabhadra project, the Machand project, etc., co-operation of two or three Governments is essential. Thus there is need for a central co-ordinating body for pooling the resources and for their efficient development. The formation of the Central Technical Power Board by the Government of India is, therefore, most welcome in this connection. The work of the Board would no doubt be directed predominantly towards development of the potential power resources, but in addition is bound to be of invaluable assistance to the existing electric supply organizations and in the development of the electrical manufacturing industry.

At present the electric supply organizations, in India, are severely handicapped as regards technical facilities in solving many of their problems. As an example, and perhaps as one of great urgency, could be mentioned the lack of adequate high voltage testing facilities. A high voltage testing laboratory is essential for solving many of the pressing problems of the electric supply industry—especially transmission and insulation problems which are peculiar to Indian conditions. There are many such problems of electric supply requiring close study, the solving of which would ultimately lead to increase in reliability and effect considerable savings in capital cost and maintenance. In fact, increased use of electricity in industry has really only one limitation—cost. As the cost is reduced there is as yet hardly any limit in sight to further expansion of industry. It is, therefore, imperative that there should be some organization on the lines of the British Electrical and Allied Industries Research Association, England (E.R.A.)* which would undertake to solve the problems of the electric supply industry. The E.R.A. which took its birth during the last World War has even during the short period of its existence, been of immense help to the British Electric Supply and Electrical Manufacturing Industries. The scope of its work and the pressure upon its resources are still rapidly expanding.

As striking examples of the results achieved through the co-operation of the E.R.A. and the electric supply industry, a few may be mentioned.

(*i*) When the E.R.A. was formed, very little definite knowledge existed on the current-carrying capacity of underground cables. It was the general practice to give such cables too low a rating with the result that inefficient use was made of the vast capital expenditure on cable systems. The work of the Association enabled the permissible loading of many networks to be substantially raised and thus lead to millions of pounds being saved in extensions. The economy effected, by the reduction of the cost of supply, materially assisted the growth which followed.

(*ii*) In the field of rural electrification, designs of cheap overhead construction for rural distribution have been worked out by the E.R.A. and over 300 of these lines have been successfully operated and have resulted in substantial savings in cost.

(*iii*) Several years ago, it was estimated that breakdown of insulation in electrical plant was costing the supply authorities and consumers at least one million pounds per annum. It is now admitted that the work of the E.R.A. on this count alone has resulted in savings of nearly 50 per cent.

(*iv*) Apart from effecting reductions in the cost, many of the researches bear directly upon reliability and safety, thus increasing the public confidence and minimizing the consequential damages due to failures in supply.

Many more examples could be cited, but the above are sufficient to show how useful, indeed, indispensable, an organization on the lines on the E.R.A. would be to the Indian Electric Supply Industry.

As regards the electrical manufacturing industry, at present, India is indeed in a pitiable condition. Even with the existing comparatively meagre consumption of electricity, the annual consumption of electric goods is over Rs. 6 crores. Yet there is no well organized large-scale manufacture. The production is more or less limited to a few articles such as cables and wires manufactured by the Indian Cable Co., at Jamshedpur, small transformers and insulators manufactured by the Mysore Government concerns at Bangalore, and lamps manufactured at Calcutta, Bombay, Agra and Bangalore. These meet only to a very small extent the demands of the country. India is depending on foreign import even for the simplest of her requirements in the matter of electrical equipment. With expansion of power the need for electrical machinery would be greatly enhanced and India can ill-afford to continue to import from abroad. The war has, however, already given a stimulus in this field as in many others, and a number of small concerns are springing up in the country for the manufacture of articles such as fans, heaters, radio components, small motors, electric light fittings, etc. In the post-war period the development would, no doubt, be on a much larger scale. But before an industry could be started and

* Details regarding E.R.A. and its activities are found else where in the issue.

established on a sound basis there would be a number of pressing problems peculiar to Indian conditions, such as a thorough investigation of the question of proper utilization of indigenous raw materials, etc., requiring immediate attention; and in this respect also, India badly needs an organization of the type of E.R.A. which will be of the greatest assistance to the Electrical Manufacturing Industry.

The phenomenal expansion of the electrical and allied industries in the past twenty-five years in England is due to a large extent to the work of the E.R.A. Manufacturers have also found the Association indispensable for the preparation of standard specifications. Mention must be made of the exceptionally valuable work done by the E. R. A. in the field of insulation alone. Their investigations cover a very wide field and include materials such as fabrics, tapes, varnished cloths, varnishes, enamels, filling compounds, paper, mica, asbestos press-boards, vulcanized fibre, ebonite and composite insulating materials based on synthetic resin, etc. The results of their investigations have not only effected definite improvements both in the properties of the insulating materials and in the technique of their selection and utilization, but also have led to considerable expansion of the industries themselves.

Towards its establishment and maintenance the E.R.A. receives generous financial support from the Government through the Department of Scientific and Industrial Research (D.S.I.R.), the Central Electricity Board, the B.B.C. and the G.P.O., the British Electrical and Allied Manufacturers' Association (B.E.A.M.A.), the Institution of Electrical Engineers (I.E.E.), the Cable Manufacturers' Association (C.M.A.) and many electric supply undertakings. The expenditure of the Association is now over £100,000 per annum and would have been much higher had it not been for the diversion of energy and personnel caused by the war effort.

Unfortunately in India there are as yet no organizations corresponding to the I.E.E., B.E.A.M.A., C.M.A., etc., which would supplement Government assistance in the setting up of a Research Association on the lines of the E.R.A. Hence the inception and direction of its activities in the early stages at least will have to rest mainly with the Government through the Central Technical Power Board. Research takes time, yet the results must be available in time for their utilization, hence the problem of providing facilities and building up staff to undertake the researches needed for post-war development is most urgent. A moderate beginning could be made by utilizing the existing facilities for experimental investigations in the laboratories of the Indian Institute of Science, Bangalore, and providing the Institute with some additional equipment of which the most important are those connected with High Voltage Testing, comprising:

(1) One million volt power-frequency testing equipment.
(2) Two million volt impulse-testing equipment.
(3) 200-KV high voltage D.C. testing equipment.
(4) A 125-KV H.F. testing equipment.

The approximate cost of the above equipment based on pre-war prices would amount to about Rs. 4 lakhs. A suitable building to house the above would, in addition, cost another lakh of rupees.

In due course the organization could have its own laboratory and staff.

H. N. Ramachandra Rao.

OBITUARY

THE LATE DR. S. L. GHOSE

The news of the premature death of Dr. S. L. Ghose, Professor of Botany, Government College, Lahore, has been received with profound sorrow by his numerous friends, colleagues and pupils. His departure from this world at an early age of fifty-two has created a gap in the ranks of Indian workers in Botany which is hard to fill.

S. L. Ghose was the youngest son of Mr. N. C. Ghose, who served as headmaster in many high schools in the Punjab and N.W.F.P. Born on 13th December 1893, he received education in many schools and ultimately passed his Matriculation from the Government High School, Ludhiana. He joined the Forman Christian College, Lahore, in 1908, and developed interest in biological sciences in his early years and in 1910 shifted to Government College, Lahore, where he had a brilliant academic career. In 1921 he proceeded to the University of Cambridge and worked under the guidance of Dr. A. C. Seward and Doctor Borraidale. For his researches on Myxophycæ, he was awarded Doctorate in Philosophy in 1923. He joined the University of Rangoon the same year and was responsible for establishing the Biology Department. In 1928, he returned to Government College, Lahore, as Assistant Professor of Botany, and on the death of Dr. S. R. Kashyap, he was appointed Professor of Botany, which post he held with distinction till his death on March 24, 1945.

He was elected Vice-President of the Indian Botanical Society for 1922-23, and was President of the Botany Section of the Patna Session of the All-India Science Congress in 1933.

His contributions to the study of Myxophyceæ of Northern India and Burma are of an outstanding nature and by his pioneer work he showed the way to others into a realm hitherto practically untouched and unexplored. He was the author of twenty original papers of outstanding merit. By his genial temperament and sympathetic approach he had endeared himself to all his pupils. Besides being an inspiring teacher he was a sympathetic guide in the field of research. Indian Algology has suffered an irreparable loss by the demise of this veteran and the Panjab University an inspiring professor of Botany.

M. S. Randhawa.

LETTERS TO THE EDITOR

A NOTE ON HOTELLING'S T^2

In a previous note[1] on the generalized variance of a multivariate population it has been pointed out that the generalized variance

$$\begin{vmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{vmatrix}$$

usually represented by $|a_{ij}|$ is equal to

$$S^2_1 \, S^2_{2\cdot1} \, S^2_{3\cdot12} \cdots\cdots S^2_{n12\cdots n-1},$$

where $a_{ij} = \frac{1}{N} \sum_{\alpha=1}^{N} (x_{i\alpha} - \bar{x}_i)(x_{j\alpha} - \bar{x}_j)$, and $S^2_{n\cdot12\cdots n-1}$ is the residual variance of x_n of the sample expressed as a linear function of $x_1, x_2, x_3, \ldots x_{n-1} \cdot x_1, x_2, \ldots x_n$ are the variates of the population whose means are $m_1, m_2 \ldots m_n$ and N is the size of the sample, $\bar{x}_1, \bar{x}_2, \ldots \bar{x}_n$ are the sample means of the n variates.

This result can be proved by using the relation (given by Yule and Kendall).[2]

$$S^2_{n\cdot12\cdots n-1} = \frac{\begin{vmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{vmatrix}}{\begin{vmatrix} a_{11} & a_{12} & \cdots & a_{1n-1} \\ a_{21} & a_{22} & \cdots & a_{2n-1} \\ \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots \\ a_{n-1\cdot1} & a_{n-1\cdot2} & \cdots & a_{n-1\cdot n-1} \end{vmatrix}}$$

for $n = 1, 2 \ldots\ldots n$, and multiplying them.

Hotelling's[3] T^2 is defined by the relation

$$\frac{T^2}{N-1} = \frac{|e_{ij}|}{|a_{ij}|} - 1,$$

where $e_{ij} = a_{ij} + (\bar{x}_i - m_i)(\bar{x}_j - m_j)$.

Like $|a_{ij}|$, $|e_{ij}|$ also can be shown to be equal to

$$S_1'^2 \, S'^2_{2\cdot1} \, S'^2_{3\cdot21} \cdots\cdots S'^2_{n\cdot12\cdots n-1},$$

where $S'^2_{n\cdot12\cdots n-1} = S^2_{n\cdot12\cdots n-1} + \bar{x}^2_{n\cdot12\cdots n-1}$, $\bar{x}^2_{n\cdot12\cdots n-1}$ stands for $[(\bar{x}_n - m_n) - b_{1n\cdot23\cdots n-1}(\bar{x}_1 - m_1) - b_{2n\cdot13\cdots n-1}(\bar{x}_2 - m_2) \ldots b_{n-1\cdot n\cdot12\cdots n-2}(\bar{x}_{n-1} - m_{n-1})]^2$. The b's are the partial regression coefficients of x_n on $x_1, x_2 \ldots\ldots x_{n-1}$ of the sample. industrial and technical establishments trough

$$\text{Hence } \frac{T^2}{N-1} = \frac{|e_{ij}|}{|a_{ij}|} - 1$$

$$= \frac{S'^2_1 \, S'^2_{2\cdot1} \ldots S'^2_{n\cdot12\cdots n-1}}{S^2_1 \, S^2_{2\cdot1} \ldots S^2_{n\cdot12\cdots n-1}} - 1.$$

By finding the kth moment of $\frac{|a_{ij}|}{|e_{ij}|}$ Wilks[4] has shown that the distribution of $Y = \frac{|a_{ij}|}{|e_{ij}|}$ is given by

$$\frac{\Gamma\frac{N}{2}}{\Gamma\frac{N-n}{2}\,\Gamma\frac{n}{2}} \cdot Y^{\frac{N-n}{2}-1} (1-Y)^{\frac{n}{2}-1} dY$$

with a range from 0 to 1.

We will now get the distribution of $Z_1 Z_2 \ldots\ldots Z_n$,

where

$$Z_r = \frac{S^2_{r\cdot12\cdots r-1}}{S^2_{r\cdot12\cdot r-1} + [(\bar{x}_r - m_r) - \beta_{1r\cdot23\cdots r-1}(\bar{x}_1 - m_1) - \beta_{2r\cdot13\cdots r-1}(\bar{x}_2 - m_2) \ldots \beta_{r-1\cdot r\cdot12\cdots r-2}(\bar{x}_{r-1} - m_{r-1})]^2}$$

The β's are the population values of the partial regression coefficients.

The distributions of $X_r = \frac{N \, S^2_{r\cdot12\cdots r-1}}{\sigma^2_{r\cdot12\cdots r\,1}}$ and

$$Y_r = \frac{N\,[\bar{x}_r - m_r) - \beta_{1r\,23\cdots r-1}\,(\bar{x}_1 - m_1)\ldots - \beta_{r-1\cdot r\cdot 12\cdots r-2}\,(\bar{x}_{r-1} - m_{r-1})]^2}{\sigma^2_{r\,12\cdots r-1}}$$

are given by

$$K_r\cdot \mathrm{Exp.} - X_r \cdot X_r^{\frac{N-r-2}{2}}\, dX_r \text{ and}$$

$$C_r\cdot \mathrm{Exp.} - Y_r \cdot Y_r^{-\frac{1}{2}}\, dY_r.$$

$\sigma^2_{r\cdot 12\cdot r-1}$ stands for the residual variance of the population corresponding to $S^2_{r\,12\cdot r-1}$.

Now $X_1, X_2, \ldots\ldots X_n$ and $Y_1, Y_2\ldots\ldots Y_n$ are independent of one another and hence the kth moment of $Z_1 Z_2 \ldots Z_n = \left(\frac{X_1}{X_1+Y_1}\right)\left(\frac{X_2}{X_2+Y_2}\right)\ldots\ldots\left(\frac{X_n}{X_n+Y_n}\right)$ is the product of the kth moments of $\left(\frac{X_1}{X_1+Y_1}\right)$; $\left(\frac{X_2}{X_2+Y_2}\right)$; $\ldots\ldots\ldots$ $\left(\frac{X_n}{X_n+Y_n}\right)$. The kth moment of $\frac{X_1}{X_1+Y_1}$ is equal to

$$\frac{1}{\Gamma\frac{N-1}{2}\Gamma\frac{1}{2}} \int_0^\infty \int_0^\infty e^{-(X_1+Y_1)} \times \frac{X_1^{\frac{N-3}{2}+k}}{(X_1+Y_1)^k}\cdot Y^{-\frac{1}{2}}\, dX_1\, dY_1.$$

Using the integral

$$\int_0^\infty \int_0^\infty \phi\,(x+y)\, x^\alpha y^\beta\, dx\, dy = \frac{\Gamma\alpha+1\,\Gamma\beta+1}{\Gamma\alpha+\beta+2} \int_0^\infty \phi\,(z)\, z^{\alpha+\beta+1}\, dz,$$

it can be shown that the kth moment of $\frac{X_1}{X_1+Y_1}$ is equal to

$$\frac{\Gamma\frac{N-1}{2}+k\;\Gamma\frac{N}{2}}{\Gamma\frac{N-1}{2}\;\Gamma\frac{N}{2}+k}.$$

Similarly the moments of $\frac{X_2}{X_2+Y_2}\cdots\frac{X_n}{X_n+Y_n}$ can be calculated and the product of these moments is

$$\frac{\Gamma\frac{N}{2}\;\Gamma\frac{N-n}{2}+k}{\Gamma\frac{N}{2}+k\;\Gamma\frac{N-n}{2}}.$$

It is obvious that the kth moment of $\frac{|a_{ij}|}{|e_{ij}|}$ is the same as $Z_1 Z_2 \ldots Z_n$. Hence the distributions also are the same.

It is now worth while to examine the exact difference between $\frac{|a_{ii}|}{|e_{ij}|}$ and $Z_1 Z_2 \ldots Z_n$.

We have already seen that

$$\frac{|a_{ij}|}{e_{ij}|} = \frac{S^2_1\, S^2_{2\cdot 1}\ldots S^2_{n\cdot 12\cdots n-1}}{S'^2_1\, S'^2_{2\cdot 1}\ldots S'^2_{n\cdot 12\cdots n-1}} \text{ and } Z_1 Z_2\ldots Z_n$$

can be considered to be equal to

$$\frac{S^2_1\, S^2_{2\cdot 1}\ldots S^2_{n\cdot 12\cdots n-1}}{S''^2_1\, S''^2_{2\cdot 1}\ldots S''^2_{n\cdot 12\cdots n-1}},$$

where

$$S''^2_{r\cdot 2\cdots r-1} = S^2_{r\cdot 2\cdots r-1} + \{(\bar{x}_r - m_r) - \beta_{r\cdot 2\cdots r-1}\,(\bar{x}_1 - m_1) - \beta_{2r\cdot 13\cdots r-1}\,(\bar{x}_2 - m_2) - \ldots\ldots \beta_{r-1\cdot r\cdot 12\cdots r-2}\,(\bar{x}_{r-1} - m_{r-1})\}^2.$$

It is obvious that the difference between $\frac{|a_{ij}|}{|e_{ij}|}$ and $Z_1 Z_2\ldots Z_n$ lies in the fact that while S′'s are calculated on the basis of sample regression coefficients, S″'s are based on the regression coefficients of the population.

The distribution of either T^2 or $Z_1\; Z_2\ldots Z_n$ can be used to test whether two samples belong to one and the same multivariate population. If the sizes of the samples are N_1 and N_2,

$$Z_r = \frac{S^2_{r\cdot 12\cdots r-1}}{S^2_{r\cdot 12\cdots r-1} + \frac{N_1 N_2}{(N_1+N_2)^2}\{(\bar{x}''_r - \bar{x}'_r) - \beta_{1r\cdot 2\cdots r-1}(\bar{x}''_1 - \bar{x}'_1) - \ldots\, \beta_{r-1\cdot r\cdot 12\; r-2}(\bar{x}''_{r-1} - \bar{x}'_{r-1})\}^2}.$$

Here $S^2_{r\cdot 12\cdots\cdots r-1}$ is the pooled estimate of the variances within the two samples together and $\bar{x}_r''$ and $\bar{x}_r'$ are the means of the samples. The distribution of Y in this case is obtained by substituting $N_1 + N_2 - 1$ for N in the distribution given by Wilks.

If two samples belong to populations with different means and the same variances and covariances, it can be shown that the values corresponding to $Z_1\; Z_2\;\ldots\; Z_n$ discussed abo\ is given by a similar expression

$$Z_1'Z_2' \ldots\ldots\ldots Z_n',$$

where

$$Z'_r = \frac{S^2_{r\cdot 12\cdots r-1}}{S^2_{r\cdot 12\cdots r-1} + \frac{N_1 N_2}{(N_1+N_2)^2}[\{(\bar{x}''_r - \bar{x}'_r) - (m''_r - m'_r\} - \beta_{1r\cdot 2\cdots r-1}\{(\bar{x}_1'' - \bar{x}'_1) - (m''_1 - m'_1)\} - \ldots\; \beta_{r-1\cdot r\cdot 12\cdots r-2} \times \{(\bar{x}''_{r-1} - \bar{x}'_{r-1}) - (m''_{r-1} - m'_{r-1}\}]^2}.$$

The distribution of this quantity is identical with that of $Z_1\; Z_2\;\ldots\ldots\; Z_n$. It can be shown that a relation similar to that between T^2 and $Z_1 Z_2\;\ldots\; Z_n$ exists between Bose and Roy's[5] D^2-statistic when $\Delta \neq 0$ and $Z_1'Z_2'\;\ldots Z_n'$, with the difference that the distribution of $Z_1'Z_2'\;\ldots\; Z_n'$ is far simpler than that of the D^2-statistic.

It may, further, be pointed out that the distribution of D^2 involves Δ^2. $Z_1'Z_2'\;\ldots\ldots Z_n'$ can be calculated if all the quantities necessary for calculating Δ^2 are known and hence it is immaterial whether we use D^2-statistic or $Z_1'Z_2'\;\ldots Z_n'$. But as the distribution of the latter expresssion is simpler and can be had from the existing tables, the probability of observed differences between the means of two samples from two populations with given

differences between their means for the different variates can be easily obtained.

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October 3, 1944.

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'*ZERO ORDER*' REACTIONS UNDER ELECTRIC DISCHARGE

1. As ordinarily formulated the law of Mass Action implies thermal changes. Its wider significance is, however, indicated by the fact that the Mass law expressions hold for the kinetics of photochemical, especially photocatalytic reactions; spontaneous recombination of opposite ions in gases; radioactive changes including both consecutive and Wegscheider type simultaneous reactions; equilibria in the ionisation of weak electrolytes and of others at low concentrations; decrease of the micellar 'primaries' as envisaged in Smoluchowski's theory of coagulation, etc.[1] It is now suggested that the progress of a discharge reaction may also be considered, under certain conditions, from the standpoint of the Mass law.

2. For a reaction of the nth order, it is shewn that,

$$k = \frac{1}{t\,(n-1)}\left\{(a-x)^{-(n-1)} - a^{-(n-1)}\right\} \qquad \text{(i)}$$

$$= \frac{a^{-(n-1)}}{t\,(n-1)}\left\{\left(1-\frac{x}{a}\right)^{-(n-1)} - 1\right\} \qquad \text{(ii)}$$

where the various symbols have their familiar significance. If now t is such that the corresponding fractional change x/a is small, we can write to a sufficient approximation,

$$k = \frac{1}{t\,(n-1)\,a^{(n-1)}}\left\{1 + (n-1)\frac{x}{a} - 1\right\} \qquad \text{(iii)}$$

$$t = \frac{1}{k\cdot a^{(n-1)}}\cdot\frac{x}{a}\,;\ \frac{x}{a} = k.t.a^{(n-1)} \qquad \text{(iv)}$$

(iv) may also be obtained directly from the Mas law expression for the average velocity $\Delta x/\Delta t = k(a-x)^n$; the simplifying approximation giving (iii) may then be introduced. (iv) leads to the familiar method of determining the 'order' of a reaction from observation of the influence of the initial concentration a upon time t corresponding to given x/a, and *vice versa. The derivation* (i-iv) not found in the literature, gives a theoretical basis for this method; its applicability is limited by conditions implied in the approximation leading to (iii). In actual practice x/a as high as 0·5 would appear to be permissible.

3. Putting $n = 0$ in (iv) yields the empirical test for a 'zero order' reaction. It is that for a given t, x/a increases directly as, or what is the same thing, that the absolute rate of change is independent of, a. These reactions occur almost entirely on either the walls of the reaction vessel or/and on a catalyst surface;[2] loss in this amount of the reactant material during reaction is made good by adsorption from the homogeneous phase.[2] Changes in the concentration of the latter will not affect sensibly the amount adsorbed and, therefore, the corresponding nett rate of the reaction.[2]

The frequent occurrence under electrical discharge of the 'clean up' and allied phenomena suggest that the type of effects leading to consequences as indicated above might well obtain in discharge reactions. It is instructive here to cite certain results on the newly observed light-effect,[1,6,3,4,7] *viz.*, Δi an instantaneous and reversible change on exposure to an *external* radiation of the discharge current i. It is found that Δi varies appreciably due to 'ageing' under the discharge,[1,3,4] and, that its time-rate depends markedly on the nature of any pre-treatment to which the discharge tube was subjected.[1] By giving appropriate coats on the container walls, it has been possible not only to alter very markedly the magnitude but the *sign* of the light-effect.[1] These results point to a variable adsorption-like layer as an important determinant of the phenomenon.[1,5] The subsequent observation of a periodic effect[1,5] in the nitrous oxide, hydrogen interaction under discharge showing not only a rhythmic variation of the rate of change but (during certain stages) of its direction is easily explicable, on the assumption of an intermittent formation and break up of a layer on the electrodes, producing a variation of the surface gradient, of the 'threshold potential' V_m[1,6,7,5] and, therefore, of the corresponding electrical quantities during the reaction as observed.[1,6,7,5] It follows, therefore, that (a) a large surface : volume ratio as in an ozoniser type discharge tube would favour the occurrence of such a periodic effect and that (b) this surface action leading to 'zero order' changes need not necessarily be confined to ordinary adsorption, *viz.*, that produced in absence of an external electrical field. Work is in progress to investigate the limits of the validity of (a); (b) is to be anticipated from general considerations of the discharge phenomena.

4. Alternatively to, or what is more likely, simultaneously with the mechanism considered in para 3, the change may be caused photochemically by the *internal* radiation produced in the reaction space under discharge. It is considered that adsorption as in para 3 of the reactant material and its activation in the discharge increases its optical absorption. This last towards the *internal* radiation may be total or feeble; the order of the corresponding change, therefore, would be zero or one respectively.

Department of Chemistry,
Benares Hindu University, S. S. JOSHI.
February 9, 1945.

1. Joshi, *Pres. Address, Indian Sci. Cong. Chem. Sec.*, 1943. 2. *Cf.* Hinshelwood, *Kinetics of Chemical Change in Gaseous Systems* (Oxford). 3. Joshi and Deshmukh, *Nature*, 1941, **147**, 806. 4. Deo, *Proc. Indian Acad.*, 1945, **A. 21**, 76–80. 5. Joshi and Deshmukh, *Nature*, 1945, **155**, 483. 6. Joshi, *Curr. Sci.*, 1939, **8**, 48. 7. —, *Nature*, 1944, **154**, 147.

NEUTRALISATION OF SPACE-CHARGE OF HOT METALS BY POSITIVE IONS OF POTASSIUM

In previous experiments[1] it was observed that high velocity positive ions of mercury did not have any effect on the Space-Charge of a hot filament and thus no change in its thermionic emission was detected when a beam of mercury positive ions was fired on it. The negative results in these experiments were probably due to the low intensity of the Mercury positive ion beam used.

In the present work investigations have been carried out with slow Potassium positive ions of much greater intensity. The apparatus consisted of a thin Tungsten filament surrounded by a Nickel cylinder which served to collect the thermionic electrons from it. The filament was heated by the secondary of a low tension transformer. A very fine hole was made in the cylinder opposite the filament and a plate was placed outside the cylinder to collect the electrons issuing out of the fine hole. This electron current was measured with a galvanometer of the sensitivity of 10^{-10} amps./mm. The thermionic current to the cylinder was measured with a milliammeter. A beam of positive ions of Potassium was fired on the filament and the variations in the electron current to the plate was observed in the galvanometer for varying intensity of the beam of positive ions of different velocities. The observations were taken at different temperatures of the filament. The results shown in Figs. (1) and (2) are typical of a large number of curves obtained.

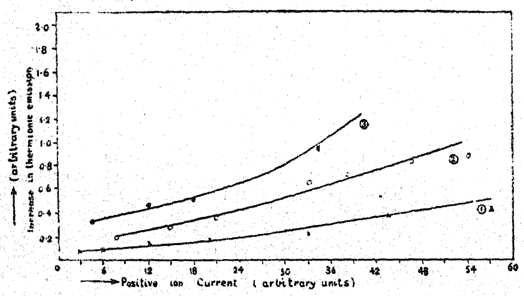

FIG. 1

Filament heating current = 4·4 (arbitrary units)
Anode Voltage = 10·0 volts
Positive ion accelerating voltage:—
Curve 1, 8·0 volts.
Curve 2, 4·0 volts.
Curve 3, 2·0 volts.

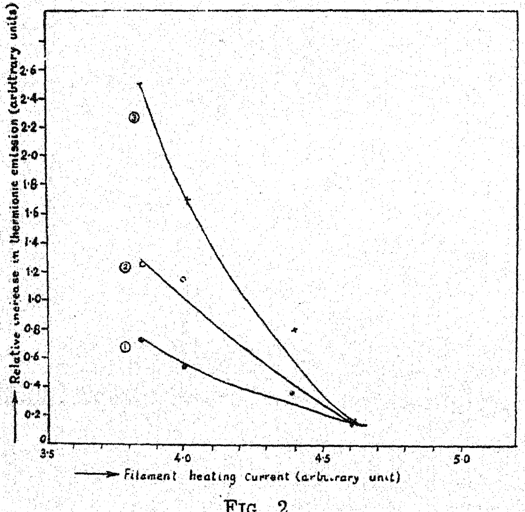

FIG. 2

Positive ion current = 42·0 (arbitrary units)
Anode voltage = 10·0 volts
Positive ion accelerating voltage:—
Curve 1, 8·0 volts.
Curve 2, 4·0 volts.
Curve 3, 2·0 volts.

The curves in Fig. 1 show that:—

(1) The thermionic emission from the filament at a particular temperature rises almost linearly with the intensity of the positive ion beam incident on the filament.

(2) The increase in the thermionic emission at a particular temperature of the filament is less with ions of greater velocities for the same intensity of the beam.

The curves in Fig. 2 show that:—

(3) For a particular intensity and velocity of positive ions the relative increase in the thermionic emission falls off with increasing temperature of the filament.

The temperature of the filament in these experiments was always below that at which saturation current would be obtained with the anode potential used here, *viz.*, 10 volts.

Details of the experiments will be published elsewhere.

Physics Department,
Muslim University,
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May, 2, 1945.

R. M. CHAUDHRI.
ANIS AHMAD.

1. Chaudhri, R. M., Nawaz, S. M., and Aslam, M., *Proceedings, National Institute of Sciences of India*, 1939, 5, 3, 359.

ON A SPECIES OF SCHISTOSOMA RECORDED FOR THE FIRST TIME FROM THE ELEPHANT

In the course of examination of helminths from a cow-elephant which died recently in the 'Topslip' area of the Coimbatore District, the author was fortunate to meet with *Schistosomes* from the liver. Since there is no record of *Schistosomes* in the elephant either in India or elsewhere in the world, as far as known, opportunity is taken to place this on record.

The collection consisted of about a hundred worms inclusive of males and females and in a bad state of preservation as they were all picked up, dead. Attempts at a morphological study indicate that the specimen differs from all known species of the genus. Though a correct identity of the worm together with a morphological description will form the matter for a future communication the following general features noticed are mentioned here:—

Males: Fairly large sized; suckers fleshy and well-developed; cuticle covered with coarse tubercles on the dorsal surface; edges

prominently inturned, forming a well-defined gynæcophoral canal; testes as many as fifty; arranged in a string, from behind the ventral sucker; intestinal cæca unite very near the hind end.

Females: Long and slender; uterus has a single ovum, shaped a longish oval with a short, abrupt, spine at one end and covered with longitudinal ridges or rugæ on the shell. Intestinal cæca have a very zigzag course, unite more than twice and end in a short common cæcum.

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May 28, 1945.

THE "BELLIER FIGURE" AS AN ANALYTICAL CONSTANT OF VEGETABLE OILS AND ITS USE IN DETECTING ADULTERATION IN THEM

BELLIER's qualitative test for arachis oil in olive oil and its modification by Franz and Adler making the test quantitative by determining the temperature at which a turbidity is first produced are quoted by Evers.[1] This test has been adopted by H. Hawley[2] in this laboratory for detecting and estimating the amount of arachis oil in sesame (gingelly, til) oil which is very commonly adulterated, and has been extended to some other common edible oils. It has proved a rapid and fairly accurate test in the analysis of a number of oils received in this laboratory under the Madras Food Adulteration Act, *e.g.*, sesame, coconut, safflower and nigerseed oils. In fact, the turbidity temperature determined under strictly controlled conditions, as given below, is remarkably constant for a particular oil and in the writer's opinion, should rank as an analytical constant in the routine examination of oils. The writer proposes to call this the "Bellier figure".

The Bellier figure is determined as follows:—One ml. of the oil (Garratt[3] states that for this determination the oil should be accurately measured or better weighed, *i.e.*, 0·92 gm. being used. But the writer finds that there is no change in the Bellier figure even when the quantity of the oil varies by as much as 100 mg. and reproducible values can be obtained by pipetting out 1 ml.) is pipetted into a 250 ml. flat-bottomed flask and 5 ml. of 1·5 N alcoholic potash (15 ml. of 10 N potash solution made up to 100 ml. with redistilled rectified spirit of 90 per cent.) added. The mixture is heated under a reflux condenser by a tiny flame for five minutes and allowed to cool. It is then neutralized by 1·5 ml. dilute acetic acid (226 ml. glacial acetic acid of 17·3 N diluted to 500 ml. with distilled water). Lüers[4] recommends the addition of an extra three drops of glacial acetic acid in addition to the quantity prescribed by Franz and Adler.[5] The above dilution of glacial acetic acid ensures the necessary strength as recommended by Lüers. The resulting solution has a pH of 5·4. Fifty ml. of 70 per cent. (by volume) alcohol is then added. The strength of the alcohol must be accurately adjusted. It has a S.G. at 60°/60° F. of 0·8900. If a turbidity appears immediately, the contents are warmed on a water-bath till it disappears. Thirty to forty ml. of the solution is then transferred to a large test-tube fitted with a two-holed rubber cork. Through one of the holes is passed a thermometer having a range of 0-50° C. reading to ½°. Through the other passes a thin glass rod bent at the bottom in the form of a circle to stir the solution. The test-tube is cooled in ice-water and stirred continuously. It is frequently taken out of the bath to avoid local supercooling and the temperature at which a distinct opalescence is formed gives the Bellier figure. The figure is checked by warming till the turbidity disappears and recooling.

The saponification and iodine values have ranges such that the values for two oils sometimes overlap. On the other hand, the Bellier figure is more specific and along with refractive index appears in most cases sufficient to judge the purity of an oil. The Bellier figures and Butyro-refractometer readings of some oils are given in Table I.

TABLE I

Oil		Bellier figure	Butyro refractometer reading at 40° C.
Sesame	..	19–20	59–60
Coconut	..	13–14	35–36
Safflower	..	15–16	64–65
Nigerseed	..	25–26	63–64
Mustard seed	..	24·5*	60·5
Mustard (Rape)	..	27·5*	59·5
Arachis	..	39–40	54–55

* Fig. for one sample of oil extracted from seeds in the laboratory.

Table II gives the Bellier figure of the common edible oils when genuine and when mixed with various percentages of arachis oil given in column A.

TABLE II

A	B				
Percentage of arachis oil by weight	Turbidity temperature (Bellier figure) of the oil mixture containing the percentage of arachis oil shown in col. A and the oil mentioned below to make up the balance.				
	Gingelly	Coconut	Safflower	Niger seed	Mustard seed
..	19—20	13—14	15—16	25 - 26	24—0
10	23—25	19·0	23·0	29·0	28·0
20	27·0	25·0	27·0	31·5	31·0
30	30·0	28·5	30·5	33·5	31·5
40	32·0	32·5	32·5	34·0	33·0
50	34·0	33·0	34·5	34·5	34·0
60	36·0	34·5	36·0	35·0	35·5
70	37·0	36·0	37·5	37·0	37·0
80	38·5	37·0	39·0	38·5	38·6
90	39·5	38·0	39·5	39·0	39·0
100	40·0	40·0	40·0	40·0	40·0

Fig. 1 shows the curves obtained when the Bellier figures are plotted against the percentages of arachis oil.

An inspection of the curve will show that although the Bellier figures increase with the percentage of arachis oil in the mixture, the increase is not proportional and that there is a steep rise for percentages of arachis oil below 25 but when the arachis oil content increases further the Bellier figures rise only slowly to the maximum of 40° C. for arachis oil itself. The percentage of arachis oil in an unknown

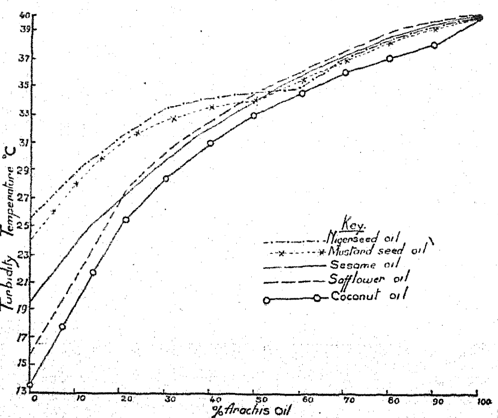

FIG. 1

sample, particularly when the percentage of adulteration does not exceed 50, is given with considerable accuracy by the Bellier figure.

The Bellier figure for genuine buffalo ghee ordinarily falls within the fairly narrow range of 28-30° and that for Vanaspati varies with the nature of the oil from which it was derived. But the values for some unquestionably genuine ghees departed considerably from this range.

My thanks are due to Mr. H. Hawley, Government Analyst, for his criticism, suggestions and encouragement, and to the Surgeon-General with the Government of Madras, for permission to publish this paper in *Current Science*.

King Institute,
Guindy, Madras, S. NARAYANAIER.
April 23, 1945.

1. *Analyst*, 1912, p. 487. 2. *Curr. Sci.*, June 1937, p. 640. 3. *Drugs & Galenicals*, 1937, p. 332. 4, *Abs. Analyst*, 1913, p. 58. 5. *Loc. cit.*

A SCIENTIFIC NEW YEAR'S DAY

SINCE the publication of the above note in *Current Science* of March 1945, 14, 68, it has been brought to my notice that there is nothing really scientific about January 1st being the New Year's Day. The argument was based on the fact that the day of the earth passing through the perihelion of its orbit has of late years been round-about January 1.

As a matter of fact, the date of perihelion is not permanent, and it is only by chance that it, at present, falls around January 1. The average date at the present epoch is January 2.

The mean tropical year, *i.e.*, the time between two successive vernal (or automnal) equinoxes, which determines the cycle of the seasons, is 365·24220 mean solar days. The time between two successive passages of the earth through the perihelion, known as the anomalistic year is, however, slightly longer. The mean anomalistic year has 365·25964 days. Thus the anomalistic year is longer than the tropical by 0·01744 of a day, or about 25 minutes, which makes perihelion come about seven days later in 400 years.

The actual time of perihelion passage fluctuates around its mean position by one or two days owing to slight irregularities in earth's motion and to the arrangement of leap years in our calendar, which will account for its variation between January 1, and January 4, during the period taken into account in the previous note.

Perihelion passage coincided with the winter solstice in about 1300 A.D. It will coincide with the vernal equinox in about 6500 A.D. at its present rate of progress.

The actual time taken by the earth to go round the sun, relative to a star, is the mean sidereal year of 365·25636 mean solar days. This is the most constant of the three types of years, changing by only a second in about 10,000 years. The tropical year changes by about a second in only 200 years.

The tropical year falls short of the sidereal due to precision of the equinoxes, which completes a full cycle in about 25,000 years. The anomalistic year exceeds the sidereal owing to the 'apse line', *i.e.*, the major axis of the earth's elliptical orbit gradually moving forward.

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Lahore, J. B. SETH.
May 18, 1945.

RELATIVE GROWTH PROMOTING POTENCY OF SOME STEROLS ON *CORCYRA CEPHALONICA* STAINT

A FAT-SOLUBLE factor for the growth and pupation of the larvæ of *Corcyra cephalonica* Staint has been shown to be essential; it was, therefore, of interest to determine whether the triglycerides, triolin, tristearin and tripalmitin in any way satisfied the fat-soluble requirement of the insect.

Newly hatched larvæ were fed for ten days on whole jowar and then transferred in weighed hatches to the experimental diets. Whole jowar and chloroform-extracted jowar were used as controls. Results are given in Table I. It may be observed from Table I that none of the triglycerides are useful in promoting the growth of the insect larvæ.

On the 21st day the larvæ were transferred from the triglyceride diets to whole jowar. The larvæ were weighed again after 11 days. The results show that the larvæ in spite of their arrested growth, retain their recuperative power and rapidly respond to the whole diet.

Our previous studies strongly suggested that sterols would probably supply the necessary

TABLE I
Average Weight of Ten Larvæ

Diet	Days					
	0	7	14	21	Weight of the larvæ 11 days after the transfer to whole Jowar	
I. Whole Jowar	5·03	24·7	121·88	394·70	Transferred to whole Jowar on 21st day	13 pupæ ; 1 larva
II. Chloroform extracted Jowar (C.E.J.)	5·60	10·68	8·98	8·63		85·48
III. C.E.J. + Triolein	5·32	9·37	8·72	6·90		79·33
IV. C.E.J. + Tripalmitin	5·36	10·85	8·32	6·67		110·91
V. C.E.J. + Tristearin	5·62	9·52	7·77	8·37		94·88

TABLE II
Average Weight of Ten Larvæ

Diet	Days				Remarks
	0	7	14	25	
A. With triolein					
I. Whole Jowar	1·80	16·46	81·50	Most pupated	Some pupated
II. Chloroform extracted jowar (C.E.J.)	1·98	2·46	1·88	No Survivals	No survivals
III. C.E.J. + Cholesterol	1·62	8·96	22·92	128·44	Some pupated
IV. ,, + Sitosterol	1·58	8·00	16·38	62·08	,, ,,
V. ,, + Phytosterol	1·62	9·34	27·78	145·92	No Pupæ
VI. ,, + Calciferol	1·72	2·58	3·72	3·82	,, ,,
B. Without triolein					
I. C.E.J. + Cholesterol	1·62	10·82	36·62	165·92	No pupæ
II. ,, + Sitosterol	1·66	11·54	36·08	122·28	,,
III. ,, + Phytosterol	1·86	11·22	20·64	102·40	,,
IV. ,, + Ergosterol	1·86	8·94	17·82	78·18	,,

TABLE III
Average Weight of Ten Larvæ

Diet	Days			Remarks
	0	18	25	
A. With triolein				
I. Whole Jowar	12·20	200·26	All pupated	All pupated
II. C.E.J. + Cholesterol	14·56	121·48	168·70	No pupæ
III. ,, + Sitosterol	12·84	70·94	136·12	Some pupated
IV. ,, + Phytosterol	13·50	91·14	186·00	Some pupated
V. ,, + Calciferol	15·32	11·58	No survival	—
B. Without triolein				
I. C.E.J. + Cholesterol	23·88	140·58	151·72	Some pupated
II. C.E.J. + Sitosterol	22·14	108·92	168·12	No pupæ
III. C.E.J. + Phytosterol	22·62	155·84	206·00	Some pupated
IV. C.E.J. + Ergosterol	24·02	129·98	170·64	No pupæ

fat-soluble growth requirement of the Corcyra larvæ; experiments were accordingly carried out supplementing the basal diet (chloroform-extracted jowar) with 1 mg./gm. cholesterol, ergosterol, sitosterol, phytosterol and calciferol respectively with and without the addition of triolein (4·28 g./100 g. of chloroform-extracted jowar). Results are given in Tables II and III.

From the above tables it may be seen that the cholesterol, sitosterol, phytosterol and ergosterol can each satisfy the fat-soluble factor requirements of the insect. The addition of triolein does not influence the rate of

growth nor the time required for pupation. Calciferol on the other hand does not support the growth of Corcyra larvæ and appears to exert a toxic effect.

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June 4, 1945.

ALGEBRA RELATED TO PARTICLES OF SPIN $^3/_2$

ONE of us (B. S. M.) has considered [(1942), referred to here as I], the question of deriving commutation rules for the matrices β appearing in the relativistic wave-equation of a particle of arbitrary spin in the form

$$\partial_\mu \beta_\mu \psi + \chi\psi = 0 \qquad (1)$$

of the famous Dirac equation for a particle of spin ½. It was there shown that this problem could be solved by making the new assumption that the spin operator $t_{\mu\nu} = i\, s_{\mu\nu}$ satisfies the condition

$$t_{\mu\nu} = (\beta_\mu, \beta_\nu) \equiv \beta_\mu\beta_\nu - \beta_\nu\beta_\mu \qquad (2)$$

for all spins.

The general commutation valid for all spins can then be written as

$$(\beta_\mu, t_{\nu\rho}) = (\beta_\mu, (\beta_\nu, \beta_\rho)) = \delta_{\mu\nu}\,\beta_\rho - \delta_{\mu\rho}\,\beta_\nu \qquad (3)$$

The special clases of spins $^3/_2$ and 2 were considered in I, and the restricted forms of (3) on the further assumption that the eigenvalues of $s_{\mu\nu}$ for a particle of spin s are s, $s-1$, ..., $-s+1$, $-s$, were also given there [I, (26) and (34)] for these cases.

The imposition of condition (2), while it solves this particular problem of deriving the commutation rules, has also very far-reaching consequences in that it makes wave-equation (1) itself of fundamental importance in obtaining properties of the elementary particles. Bhabha (1945, *a*, *b*, *c*) has recently considered the full implications of the assumption (2) and shown that the problem of finding all irreducible equations of form (1) can be connected with that of finding all irreducible representations of the Lorentz group in five dimensions. He has further shown that, on this theory, a particle of maximum spin n must appear with n different values of the rest-mass if n is an integer, and $n + ½$ values if n is half an odd integer, the higher values of the rest-mass being simple rational multiples of the lowest value.

On the basis of his new theory Bhabha has considered (1945, *c*) in particular, the two possible equations of the form (1) for a particle of maximum spin $^3/_2$, and indicated, by consideration of the non-relativistic approximation, that the equation given by one of the representations denoted by $R_5(^3/_2, ½)$ may possibly describe the behaviour of the proton. The degree of this representation, *viz.*, 16, and the explicit expression for the same have also been derived by him [*ibid.*, (74) and (76)].

We have independently investigated the algebra generated by the commutation rules for the case of spin $^3/_2$ [(I, (26)] exactly on the pattern given by Kemmer (1939) for the case of spin one (Meson algebra). The investigation is not too laborious on account of the fact that the algebra becomes the direct-product of two sub-algebras, one being the Dirac algebra of rank 16, and another, which we call the ξ-algebra, of rank 42. Thus there is really no need to count the 672 (16×42) linearly independent quantities generated by the β_μ, I and all powers and products of the β_μ. The dimensionality of the representations is then decided by the relation: $42 = 1^2 + 4^2 + 5^2$ pertaining to the ξ-algebra, and given by (4×1), (4×4), (4×5), *i.e.*, 4, 16 and 20 for the original algebra. Of these the first relates to the case of spin ½ and may be discarded. It can also be shown that the algebra for the case of all half-integral spins is the direct product of the Dirac algebra and an associated ξ-algebra.

The commutation rule for spin $^3/_2$ is likely to prove useful in investigations relating to the above-mentioned theory of Bhabha for the proton, and the associated ξ-algebra which is easier to handle than the original β-algebra might be used in the related calculations. We have also derived the representation matrices for the ξ-algebra in both the representations of orders 16 and 20.

The related results will be published in detail elsewhere.

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V. R. THIRUVENKATACHAR.
Department of Mathematics,
Central College,
Bangalore,
July 20, 1945.

Bhabha, *Curr. Sci.*, 1945, **14**, 89–90, (*a*); —, *Rev. Mod. Phys.*, **1945** (in course of publication), (*b*); —, *Proc. Ind. Acad. Sci.*, 1945. **21**, 241–64, (*c*). Kemmer, *Proc. Roy. Soc.* A, **1939**, **173**, 91–116. Madhava Rao, *Proc. Ind. Acad. Sci.*, 1942, **15**, 139–47; *J. Mys. Univ.*, **1942**, **3**, 59.

SCIENTIFIC RESEARCH AND INDUSTRY IN U.S.A.

WITH reference to his address on "Scientific Research and Industry in U.S.A.," published in the April 1945 issue of the Journal (*Curr. Sci.*, 1945, 14, 90), Sir J. C. Ghosh writes to us under date July 9, 1945, that "Some statements which been made on the basis of information which was given to me when I was in America regarding the oil fields in Bahrein Island and in Arabia. My friend, Mr. P. Evans, of the Burmah Oil Co., informs me that some of the statements made there may not be quite accurate."—ED.

REVIEWS

Plastics for Production. By Paul I. Smith. (Chapman & Hall, Ltd., London, W.C. 2), Pp. viii + 180. Price 12*sh.* 6*d.* net.

The development of the chemistry and technology of plastics has received a tremendous stimulus under the stress of a war-time economy which brought about a crisis in the supply of a variety of strategic materials, particularly metals and natural rubber. In the process of conserving these valuable raw materials, the rich and fertile field of plastics has been intensively explored; this has resulted not only in the finding of new and better plastics but also in the evolution of new production methods. The urgency and speed with which munitions of war had to be forged in quantity gave unlimited scope for the plastics to display their eminent suitability for and meet essential requirements of modern production methods.

The volume under review gives in outline the factors which determine the choice of a plastic and describes the entire range of plastics at present available. The succeeding few chapters are devoted to a critical survey of the plastics for electrical insulation, chemical resistance and mechanical strength. A very valuable feature of the book consists of the technical data which would be helpful in determining the suitability of a plastic for a given purpose.

"To those who consider that the plastics industry offers many lucrative opportunities for employment and investment of capital after the war this book will, it is hoped, act as a guide revealing within the limitations imposed by security, the main types of materials available at the present time and their suitability or otherwise for industrial purposes. In addition, I have tried to give brief glimpses of the 'shape of things to come.'"

The subject-matter is presented on a broad canvas through which the essential principles of production could be easily pictured. It is a volume which would be welcomed not only by the production engineer and the business executive but also by those who wish to keep abreast of the technological developments in the field of plastics.

Hay Fever Plants. By Roger P. Wodehouse. (Chronica Botanica Co., Waltham, Mass., U.S.A.; Macmillan & Co., Calcutta), 1945. Pp. 245. Price $4.75.

There is an element of scientific romance in this book. In the companion volume of Prof. Erdlmann we come to know the prominence attached in recent times to analytical studies on pollen in so far as they aid in the interpretation of such phenomena as peat-formation, geologic formation of areas, geographical distributional frequency of past and present vegetation, its value in systematics and above all, in the production of honey. But, that pollen grains should be the subject of study from this entirely new angle is an example of new pathways in scientific thought.

Pollen grains—which were regarded as innocuous and intended only for plant reproduction—should yet have an additional intrinsic medical worth too, is indeed, a strange revelation, and increasing importance is attached to the study of this subject in recent times, attention being paid to it by the Botanist and the Medical man alike. The volume under review is a testimony to its present position in the scientific pursuit of strange and new fields concerned with human welfare. The aim of the author is rightly said in the preface to be "to interpret the botanical facts of hay-fever in terms of their clinical significance". In this engaging volume of 245 pages, we are introduced to the subject in a simple and suggestive way and are presented with an immense array of facts of great biological bearing. Nothing that is of note escapes the attention of the writer or that of the reader. With appropriateness, the book is divided into two portions—the Botanical and the Clinical. In the former is given a direct and simple approach to the subject—the flower and the pollen. Then follow the characteristics of the pollen,—buoyancy, abundance and allergic toxicity—which cause hay-fever. The techniques of laboratory and field methods of collection, culture, observation, diagnosis and record of pollen are described in detail. Then begins a systematic enumeration of plants whose pollen occasions hay-fever. At first they relate to Gymnosperms. A succinct account of various plant species, their taxonomy, and distribution, together with figures of plants and their pollen makes very informative reading. Only few of the Gymnosperms produce hay-fever-causing pollen.

The next chapters, larger in size and in treatment, relate to Angiosperms and it is evident that the majority of plants causing hay-fever are among the species of flowering plants. These 130 pages comprise the main bulwark of the author and provide us with the best botanical account of all flowering plants responsible for this clinical phenomenon. Here are included ten phyla of Monocots, the bulk of treatment relating to grasses, both on account of their productivity and similarity of pollen, in causing hay-fever. Among monocots they constitute the main plants causing contamination and spread of this allergic disturbance. On equal footing stand the Dicots. The treatment of twenty-two families of various plant species, in all their aspects, is masterly. In common with the above, a cumulative and clear account of their description, diagnosis, systematics, and distribution, is without dissent, the most holding portion of the book. It is noteworthy, however, that among Dicots, the Compositæ have the largest number of plants causing

hay-fever and accordingly, occupy greater space and treatment. The scientific approach and scholarship of treatment coupled with a limpid style and popular appeal give a most balanced and dignified bearing to the book. The utility of the book is enhanced by providing the reader with a careful and comprehensive bibliography, a useful glossary, excellent sketches and appropriate maps. The book is a notable addition to our knowledge in this new field.

The Chronica Botanica Co. must be singled out for special mention in this connection. Amidst the turmoil of war, this Company has striven to place before the public a galaxy of sumptuous volumes in Plant Sciences. The volume under review reflects the same seductive style, the familiar format, excellent get-up and above all, stolid scholarship. K. V. S.

Life and Work of John Tyndall. By Professor A. S. Eve, F.R.S., and C. H. Creasey, O.B.E (Macmillan & Co., Ltd., London), 1945. Pp. xxxii + 404. Price 21 *sh.* net.

"But, my Lords and Gentlemen, the hardest climb, by far that I have ever accomplished, was that from the banks of the Barrow to the banks of the Thames—from the modest Irish roof under which I was born to Willis's Rooms Here I have reached my mountain-top, and you—God bless you!—have given me a bumper which no scientific climber ever before enjoyed." The biography of such a man of Science of the Victorian era who lived among giants like Darwin, Faraday, Kelvin and Maxwell ought to be interesting.

Born in 1820 as the son of a sergeant in the Irish constabulary, he had a varied early career as a surveyor and school master until in 1848 he went to the University of Marburg to work under Prof. Bunsen. That probably was the turning point in his life. In 1853 he became the Professor of Natural History at the Royal Institution and eventually succeeded Faraday as the Director of the Laboratory.

For thirty-five years not only "did he add to human knowledge by his investigations, but he expounded the knowledge for the benefit of all who could hear or cared to read". In his own day his fame rested more on his skill as a lecturer and writer for, it is perhaps true that he made no outstanding discovery. After all, as Sir John Pollock put it: "The example of straightforward seeking of the truth and endeavour to do one's best work without fear of consequence is far more important to most of us, than the precise amount which one has added to the sum of human knowledge."

Logical pursuit of truth took Tyndall from physics to metaphysics and unlike many who keep their science and religion absolutely separate, untroubled by the incongruities between them, he touched upon debatable problems in his Belfast Address to the British Association. Science made him an agnostic and he tried to see beyond natural phenomena that all-powerful and all-pervading something which he could not comprehend. "He looked through Nature up to Nature's God."

Tyndall died in 1893 and the rapid advances in Science we see to-day have not only provided opportunities for the curious to know much more science than Tyndall ever knew, but have also made individuals not indispensable.

And yet, the *Life of John Tyndall* is interesting to read and would have been much more attractive if not so voluminous.

M. K. SUBRAMANIAM.

Co-operative Electrical Research—1944 E.R.A. Publication.

Co-operation between technical experts and others concerned with the live problems of the electrical industry was almost unknown in England before the last war, and no organization existed to secure it apart from certain activities of the British Standards Institution and the Institution of Electrical Engineers. The war gave an immense stimulus to organized research and the E.R.A. took its birth in 1917 as a result of the co-operative effort of the Government (through the department of Industrial Research), the Institution of Electrical Engineers, the British Electrical and Allied Manufacturers' Association (B.E.A.M.A.), the electric supply organizations, and large consumers of manufactured products.

At first the means at the command of the E.R.A. were very moderate and left much to be desired, only meagre contributions being made towards its expenditure (which was roughly a little over £10,000) by the Government, the B.E.A.M.A., and the I.E.E. For a good many years the tasks of the Association had to be undertaken without any special laboratory; and existing facilities for experimental investigations in the laboratories of the manufacturing concerns, the power companies, the Universities and the N.P.L. were being utilized; but by 1935 the need for further facilities became urgent and the Association set up its own laboratory at Perivale.

Even during the short period of its existence, the work of the E.R.A. has been of immense help to the electric supply organizations, the electrical manufacturing industry, and the consumer alike, not to speak of its great importance in the country's war effort. It has served as the principal medium for co-ordination of research in many fields such as problems connected with (1) Power station efficiency, (2) Transmission of Electricity, (3) Electric supply, (4) Surge phenomena, (5) Transformers, (6) Switchgear, (7) Insulation, (8) Interference with communications, (9) Rural electrification and (10) Fire-fighting. The scope of research and the pressure upon the resources of the Association have increased so rapidly (the present expenditure of the Association is over £100,000 per annum) that the problem of providing further facilities and building up staff to undertake the researches needed for the post-war reconstruction has become most urgent. The E.R.A. has, therefore, decided to put up a new laboratory at Leatherhead immediately.

Judging from the magnificent record of work turned out so far the Association has more than justified itself and its activities during the post-war period would undoubtedly be even greater.

It is hoped that India would emulate the illustrious example set by England in this respect and would soon take steps for the establishment of an organisation on the lines of the E.R.A. which would be extremely valuable in post-war development.

H. N. Ramachandra Rao.

Survey of India, Geodetic Report, 1940. Price Rs. 2 or 3 *sh.*

This volume has been compiled by the War Survey Research Institute, which was formed in August 1943 and has been responsible for geodetic matters. It contains the results of investigations carried out by the Survey of India.

High precision levelling was carried out in certain portions in Orissa, C.P., and Madras. Discrepancies between the old and new heights of bench marks are given.

Both components of the deviation of the vertical were measured in 98 stations in the Punjab, Baluchistan and N.W.F.P., the object of the programme being to provide a map of the Geoid in N.W. India.

Gravity observations were made at fifteen stations in South Burma and one station in Andaman Islands. The total number of gravity stations in India has been increased to 564. Anomalies in gravity due to different causes are considered. Crustul structure lines have been drawn in the light of these results. It is inferred that the downwarp lies over the Andaman Islands and extends to Sumatra.

Of special interest is the study of the variation of latitude observations at Agra during the years 1937-40. The results show an unusually large amplitude of about one second as found at Dehra Dun during 1930-33.

Detailed discussions on various heads could not obviously be given on account of the limited time at the disposal of those in charge of the publication. The Geodetic Branch must be congratulated on the large amount of useful information collected during 1939-40 and published in this Report.

S. R. R.

Race and Cultures in India. By D. N. Majumdar. (Kitabistan, Allahabad), 1945. Pp. 299. Price Rs. 5-4-0.

Dr. Majumdar's industry and enthusiasm are both praiseworthy. In this book which, I think, is his first effort in popular writing, he maintains his liveliness and command of facts of tribal life. The benefits to the nation from a wider appreciation of some commonplaces of anthropology will indeed be out of all proportion to the cost in money and effort required in getting this knowledge transmitted to the public. I am in entire agreement with Dr. Majumdar in believing that several of our communal and regional jealousies will automatically vanish if the leaders of factions, and through them the masses, can be made to understand the meaning and implications of race and culture (language being part of culture in its wider sense). The anthropologist is not alone in putting forth this view—for he would then be denigrated as trying to sell his own wares; fortunately for the country, administrators, such as Sir Theodore Tasker who invited Dr. Majumdar to deliver a course of lectures in anthropology to the I.C.S. probationers and minor chiefs at the Dehra Dun camp, and several social workers and publicists who met recently to discuss the problems of the aborigines, are beginning to realise the value of anthropology in the administration of backward areas. This popular work of Dr. Majumdar's will give the busy man of affairs an idea of the problems facing the tribal and exterior sections of our population and, at the same time, help him to get an insight into their culture from which the so-called higher cultures of our land have developed. The book is a mine of information which the reader is not likely to come across in the usual course.

A. Aiyappan.

SCIENCE NOTES AND NEWS

Supply of "H.S." and "Specpure" Substances

The use of the spectrograph for the detection and determination of metallic elements in all kinds of materials has increased considerably in recent years. This has necessitated a demand for extremely pure elements, oxides and salts to serve as standards. Messrs. Adam Hilger, Ltd., London, have been largely responsible for the supply of such standards. About 1922, they started supplying "H.S." substances, the preparation and analysis being in the able hands of their consultant, Dr. S. Judd Lewis. In 1932, with the help again of Dr. Lewis, they introduced the "Specpure" series of "ratio powders", "ratio solutions" and pure salts. From a communication sent to us by Messrs. Adam Hilger, Ltd., we understand that, to cope with the growing demand for such substances, they have entered into an agreement with Messrs. Johnson, Matthey and Co., Ltd. Dr. S. Judd Lewis has been engaged as consultant by the latter. The agreement provides that future sales of spectroscopically standardized substances shall be made only by Messrs. Johnson, Matthey and Co., Ltd., from their Head Office at 73/83, Hatton Garden, London, E.C. 1.

In a recent article in the *Indian Medical Association Journal* ((37, 344), Chen, *et al.*, reports the successful treatment of fourteen instances of cyanide poisoning as a result of the use of combined treatment. The procedure consisted of the following three steps: (1) inhalation of amyl nitrite for 15 to 30 seconds each minute while steps (2) and (3) are being prepared; (2) injection of 10 c.c. of 3 per cent. sodium nitrite solution, intravenously, at the rate of 2·5 to 5 c.c. per minute; (3) using the same needle in the same or another vein, if

desired, inject 50 c.c. of 25 per cent. sodium thiosulphate solution. If the symptoms of cyanide poisoning return, steps 2 and 3 should be repeated, reducing the dose of each solution to one-half the stated amount. Speed in treatment is paramount, and artificial respiration should be administered, if indicated, to restore breathing. If the cyanide has been ingested, gastric lavage should be performed. The authors suggest that a treatment kit, containing proper-gauge needles and ampoules with the solutions be kept in readiness at all times wherever these hazardous substances are employed.

—(*Merck Report, April* 1945)

The recent decision of the British Empire Leprosy Relief Association to collect £210,000 "for use in the plan to exterminate leprosy within the British Empire" is laudable. For, in the British Empire there are 2,000,000 lepers!—more than half the world population of such unfortunates. It appears as if the leper problem is at last getting the attention it deserves (*cf. Curr. Sci.*, June 1945).

From time immemorial the leper has been an outcast and the fight against the scourge was half-hearted owing to the firm belief that the disease was incurable. Dr. Muir now holds out the hope of a cure if the disease is diagnosed sufficiently early and treated in time. The ancient Atreyan remedy, Hydnocarpus oil is now administered intra-muscularly as sodium-hydnocarpate and it is claimed that it destroys the lepra bacilli.

Experience has proved that compulsory isolation is impracticable and hence more stress is now laid on voluntary admissions to sanatoria where the patients are enabled to lead a normal life with their families. It appears as if this changed outlook has infused some confidence into the lepers themselves, for it is stated: "For the last ten years, more than fifty per cent. of the patients from the model leprosy sanatorium at Ngomahuru in Southern Rhodesia, have been discharged yearly as cured, and this percentage is steadily rising; more patients are being discharged than taken in."

"Leprosy is not as contagious as is generally believed. Only about one in four lepers is in that condition, and the danger is small provided certain precautionary measures are taken. *The real danger of contagion is from those who seek to hide their disease.*"

M. K. S.

The Academic Press Inc., of New York, U.S.A., will be soon publishing a *Journal of Colloid Science*, and the first issue of the Journal is expected to come out in January 1946. The following aspects of colloid science will be dealt with:—

I. *Fundamentals*: Physics, Physical Chemistry and Chemistry of Colloids and Surfaces. II. *Applications*: (1) Industry, *e.g.*, Plastics, Soaps, Photography, Food and Flotations, Emulsions. (2) Biology, Protoplasma, Cell-structure.

The Journal will be issued under the auspices of a distinguished Editorial Board and a Consultative Committee, both international in character.

Papers from India may be sent for consideration to Prof. J. N. Mukherjee, C.B.E., D.SC., University College of Science and Technology, 92, Upper Circular Road, Calcutta.

MAGNETIC NOTES

Magnetic conditions during April 1945 were slightly more disturbed than in the previous month. There were 14 *quiet* days, 14 days of *slight* disturbance and 2 days of *moderate* disturbance as against 12 quiet days, 17 days of slight disturbance and 1 of great disturbance during the same month last year.

The quietest day during April 1945 was the 27th and the day of the largest disturbance the 11th.

The individual days during the month were classified as shown below:—

Quiet days	Disturbed days	
	Slight	Moderate
3, 9, 10, 16–18, 21–23, 25–29	2, 4–8, 12–15, 19, 20, 24, 30	1, 11

No magnetic storms were recorded during April 1945 while one disturbance of moderate intensity was recorded during the month last year.

Mean character figure for April 1945 was 0·60 as against 0·63 for April 1944.

M. R. RANGASWAMI.

Magnetic conditions during May 1945 were far less disturbed than in the previous month. There were 20 *quiet* days and 11 days of *slight* disturbance as against identical numbers of quiet days and slightly disturbed days in May 1944.

The quietest day during the month was the 22nd and the day of the largest disturbance the 11th.

The individual days during the month were classified as shown below:—

Quiet days	Disturbed days
	Slight
1–8, 13, 15, 19–24, 26, 28, 29, 31.	9–12, 14, 16–18, 25, 27, 30.

No magnetic storm occurred during May 1944 or 1945.

The mean character figure for May 1945 was 0·35 as against 0·26 for May 1944.

M. R. RANGASWAMI.

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ATOMIC ENERGY

THE announcement from Washington on August 6, of the production of atomic bombs more powerful than 20,000 tons of T.N.T. and possessing blast power over 2,000 times that of the British 22,000 pounder, has taken the world by surprise. It appears that the Japanese town of Hiroshima on which it was first dropped is almost completely destroyed. The reactions that followed the above announcement can be briefly summarised. First, there was excitement that under the stress of war the process of releasing atomic (nuclear) energies on a large scale has reached a stage of perfection though for the time being for destructive purposes. Then there was a feeling of confidence that the Japanese War would come to an end sooner than expected. This has since been found to be justified. Finally, every human being capable of comprehension was shocked to hear about the devastating effect on civilization of this new and revolutionary weapon of destruction. This sense of horror was followed by a prayer that "these awful agencies will be made to conduce to peace among nations and that instead of wrecking measureless havoc upon the entire globe, they may become a fountain of world prosperity".

The idea that the core of the atom is a store-house of energy is not of recent origin. The study of the subject started with the discovery by Becqueral towards the end of the last century, of a phenomenon exhibited by uranium, the heaviest of all the known elements. This property which is now known as radio-activity is the spontaneous disintegration or splitting up of atoms with the emission of charged particles. Subsequent experiments revealed the existence of a number of radio-active substances, all of them derived from one of the two parent substances, namely uranium and thorium, which were continuously radiating and producing each a new element. Radium is one such transformation product emitting very penetrating radiations which have been used for treatment of cancer, etc. During these transformations, though small in number, energies of the order of a few million electron volts are released. (One electron-volt energy corresponds to about 10^{-12} of an erg.) In a gram of uranium about 24,000 atoms break up per second with the emission of alpha particles. (An alpha particle is a doubly ionised helium atom.) Yet the number of atoms in a gram is so great that it would take about 4,500 million years before half the atoms are transformed. As it was not possible to influence these spontaneous disintegrations of atoms by any physical processes, we could not accelerate the production of energy by this means.

Further investigations on this subject by Lord Rutherford and his school gave us some idea about the structure of atoms. It is now known that the atoms of all elements have a similar type of structure. The atom consists of a positively charged nucleus carrying most of its mass. The nuclear charge which is also called the atomic number, has a value 1 for hydrogen and 92 for uranium. The nucleus is surrounded by a cloud of negatively charged particles called electrons whose number and distribution as well as the chemical properties of the element as a whole are controlled by the nuclear charge. Elements having the same nuclear charge or atomic number but different masses are called isotopes. It is now a well-established fact that the majority of the elements consist of a mixture of isotopes.

In the ordinary chemical processes in which only the outer electrons take part, the energy released is of the order of a few electron-volts per atom; this is only about a millionth part of the energy released during nuclear transformations. It is easy to imagine the stupendous rise in energy that could be effected by carrying out nuclear transformations on a very large scale.

In 1919 Lord Rutherford showed that the nitrogen nucleus was transformed when the

latter was bombarded by the powerful projectiles of alpha particles from radioactive sources. In the succeeding years it was established that a number of light elements could also be transformed in a similar way. As a result of a close study of these artificial transformations, the existence of a new type of particle of great importance called the neutron was discovered in 1932. These are formed when the element beryllium of mass 9 is bombarded by alpha particles from radium. As the neutron is electrically a neutral particle having a mass nearly equal to that of a hydrogen nucleus, *i.e.*, a proton, it can penetrate the electrical barrier of the nucleus with but little opposition. Fermi was the first to realise that the neutron was a most promising agent for effecting nuclear transformations especially in the heavy elements.

Soon after the discovery of artificial radioactivity by Curie and Joliot in 1933, Fermi observed that radioactivity could be induced in many elements by neutron bombardment. By bombarding uranium and thorium with neutrons, Fermi and his associates obtained a series of new radioactive bodies emitting negative electrons, and from their chemical behaviour they were led to believe that these activities belonged to elements having atomic numbers greater than 92. These new elements were called trans-uranic elements. Hahn, Meitner and Strassman extended these investigations. They definitely established in January 1939 that isotopes of barium of atomic number 56 and of lanthanam 57 were formed as a consequence of the bombardment of uranium and thorium with neutrons. Similar results were obtained by Curie and Savitch almost simultaneously. These results suggested that after neutron capture the uranium or thorium nucleus splits up into two nuclei of medium atomic weight giving rise to a new type of disintegration—*nuclear fission.* Meitner and Frisch offered an explanation of the phenomenon of fission on the basis of the Böhr nuclear model. With sufficient energy of excitation, the heavy nucleus breaks up into lighter nuclei, just as a liquid drop will split up into smaller drops if enough energy is given to it. It has been shown that after splitting, the fission products will gain a total kinetic energy of the order of 200 million electron-volts. The energy released during fission is, therefore, more than twenty times the energy released in the ordinary nuclear transformations. Numerous investigations carried out in various laboratories have established that fission can be induced in uranium, thorium and protactinium not only with neutrons but also with high-energy charged particles such as deuterons, protons and alpha particles.

At the instant of fission the products are formed in a very highly excited state and consequently direct liberation of neutrons will take place. This was experimentally confirmed by Joliot, Halban and Kowarski. They showed that several secondary neutrons are emitted during each fission of the uranium nucleus. These are of a different type, *i.e.*, they are fast or high-energy neutrons. Thus a single neutron causing a rupture of the nucleus not only liberates vast quantities of energy, but also produces additional neutrons which can in turn cause further fission, thus releasing more and more energy. A great deal of interest is attached to this discovery as it leads to the possibility of a cumulative process of exothermic disintegration or chain reaction releasing terrific amounts of energy in a very short time and ending in a catastrophic explosion. This aspect of the problem which was only of theoretical interest in the year 1941, appears to have been fully worked out, resulting in the manufacture of the atomic bomb.

The necessary condition for the progress of the chain reaction is that at every stage the average number of secondary neutrons produced per fission should always be greater than the number that would be lost by capture processes which do not result in fission. This has been achieved by using fairly large quantities of a suitable compound of uranium isotope of mass 235 as the main constituent of the bomb and thermal neutrons as exciter of fission. Uranium has two isotopes, one of atomic weight 235, the other of 238. Nier, Booth, Dunning and Grosse who investigated nuclear fission in separated isotopes of uranium, showed that the yield of slow-neutron-induced fission in the lighter isotope is many times greater than in the heavier isotope. The lighter isotope is only a small fraction of the natural uranium which itself is a rare element. The practical problem is, therefore, to concentrate large quantities of the uranium of mass 235. This has been accomplished at a cost of a few hundred million sterling. Of the well-known methods of separation of isotopes, either the thermal diffusion method or the mass spectrographic method might have been developed successfully for the production of uranium 235 on a large scale.

As has already been remarked, the secondary neutrons emitted during the process of fission are of very high energy and in order to produce the chain reaction, it is necessary to introduce some hydrogen-containing substance to slow the secondary ones. Heavy water appears to have been used for this purpose. This refinement in technique has the additional advantage that during the process of slowing the high energy neutrons by collision with the heavy hydrogen or deuterium nuclei, more neutrons will be emitted as a result of the dissociation of the latter.

When once a large quantity of the atomic dynamite is available, it is comparatively easy to devise a trigger mechanism by which a beam of neutrons could be released suddenly at the right time for exploding the dynamite. It is of the utmost importance to see that the stray neutrons which are to be found everywhere due to cosmic radiation do not prematurely blow up the bomb. The use of a large quantity of silver in the manufacture of the atomic bombs has been reported. It is not unlikely that the silver may have been formed into containers for the explosive material, to absorb any stray neutrons of cosmic-ray origin.

It is estimated that one cubic metre of uranium oxide is capable of developing 10^{12}

kilowatt-hours of power in less than 0·01 sec. The sudden release of such a tremendous energy gives rise to a blinding flash many times brighter than the mid-day sun, which is followed by a tremendous and sustained roar and a heavy pressure wave. This causes destruction to men and material on a scale hitherto unknown. Because of this fact, the discovery of the atomic bomb has made warfare terrific beyond imagination. It is therefore imperative that in future the production of this new type of weapon should be effectively controlled in the interests of the whole world and not of one nation or another. It is to be hoped that in the mean time no efforts will be spared by the nations who are in the know of the secrets of the atomic bombs towards finding a suitable antidote for the same.

If the tremendous energy released from atomic explosions is made available to drive machinery, etc., it will bring about an industrial revolution of a far-reaching character. It is estimated that a pound of uranium can generate the same amount of power as a few million pounds of coal. But there are obvious difficulties connected with the control of the evolution of atomic energy. It is easier to make a destructive bomb on the atomic principle than it is to harness atomic power for peace-time purposes, and a great deal more research work is needed before atomic power can be put to industrial use. It is necessary to emphasize that the prospects of producing cheap atomic power are none too bright, however, if the chain reaction can be propagated only by slow neutrons acting on the less abundant isotope of uranium. It is to be hoped that practical ways may be found for utilising the transmutations of the commoner elements for the production of power.

R. S. KRISHNAN.

IMPERIAL CHEMICAL INDUSTRIES (INDIA) RESEARCH FELLOWSHIPS

AT the Ordinary General Meeting of the National Institute of Sciences of India held at Calcutta on the 23rd July 1945, Mr. D. N. Wadia, President, announced that he had received a letter from Lord McGowan, Chairman of the Imperial Chemical Industries, forwarding a document offering to the National Institute a sum of Rs. 3,36,000 for creating Research Fellowships in Chemistry, Physics and Biology at the Indian Universities or institutions approved by the Council of the National Institute, for over a period of five to seven years. The reasons and hopes which had prompted the Imperial Chemical Industries to offer a number of Research Fellowships to the Institute were explained by Lord McGowan in the following words:—

> "The National Institute of Sciences is, we believe, destined to play in India a part similar to that which the Royal Society of London has performed for nearly three hundred years in leading the scientific progress of this country.
>
> "The Royal Society until recent years was hampered by lack of funds and provision for the maintenance of scientific workers. This difficulty was eventually overcome by the generosity of various benefactors, including Industrialists such as Mond and Messel.
>
> "We thought, therefore, that there could be no better way of encouraging the advance of science in India and with it the general prosperity of the country than by the offer of these Fellowships which under the wise administration of your Council will, we hope, lead to an augmentation of the distinguished successes in science already attained by so many of your fellow countrymen."

The following are the terms under which the fellowships are to be created:—

1. Each fellowship to be worth Rs. 400 per month and to be tenable in the first instance for two years, with a possibility of extension up to a total of three years. (It is assumed that half the fellowships will be extended for a third year.)
2. In addition there will be a grant for research expenses to be made to the fellowship holders according to their needs of special apparatus and materials. For this purpose the National Institute will have at their disposal an average of Rs. 600 per annum for each fellowship.
3. There will be a grant of Rs. 13,200 per year to the National Institute for five years to enable them to pay for administration and the travelling expenses of such fellows of the Institute as may be selected to visit the fellowship holders at their Universities or Institutions.

The National Institute of Sciences is asked to administer the funds for the fellowships on the following principles:—

1. Appointment to and control of the fellowships to be made by the Council of the National Institute, acting on the advice of a special research fellowships committee.
2. This Special Research Fellowship Committee will represent various scientific fields and be drawn from various parts of India, so as to include any community, the over-riding consideration for membership being scientific fitness therefor.
3. The fellowships will be open to persons, irrespective of sex, race or religion, resident or domiciled in India (British India or the States) and under 35 years of age.
4. The fellowships will be tenable at any University or Institution in India, approved by the Council of the National Institute.
5. Fellows will be permitted to do a little amount of approved teaching or demonstrating. This should not be more than six hours per week and it should be a condition that they are paid for this work by the Institution or University at its normal rates.
6. The aim of the fellowships is to strengthen research in Indian Universities and Institutions, and it is hoped that the National Institute of Sciences will spread the research fellowships over them in accordance with this aim, but with the over-riding consideration of the scientific suitability of the particular University or Institution.

ONE IN ALL: ALL IN ONE

By J. J. Asana
(*Gujarat College, Ahmedabad*)

Religion, the Supreme Need of Our Scientific Age

One may feel considerable trepidition in placing before the scientific minded readers of *Current Science* the following speculations but for an equally strong feeling that they may perhaps serve a useful purpose.

This catastrophic war has taught us once again in a very striking manner how irrational and inhuman we are despite our boasted advance in scientific thought and in the application of the findings of science to the affairs of human society. Why is it so? In the analysis of the problem many causes and for its solution many remedies are being suggested. Among various measures proposed for the removal of this most distressing state of things is the reorganisation of all social and political activities on scientific lines. Industries, educational system, social and political relations of mankind, it is being urged, should be recast and remoulded in accordance with scientific methods of enquiry into problems. It seems highly probable that in the world of tomorrow workers in science will be called upon to shoulder heavier responsibilities as citizens than they have borne hitherto not only in the planning and reconstruction of industries and material environment of man but in matters pertaining to human, social relations also.

That the application of scientific methods of enquiry to industrial, economic and social problems will prove fruitful, as it has turned out so profitable in the investigation of natural phenomena, one feels little doubt. That the cold, calculating, dispassionate gaze of science may be relied upon to illuminate the entire range of all the environmental conditions amidst which mankind is living to-day appears to be a sound proposition and likely to yield results of value. But one feels that if we disregard or continue to look upon with more or less indifference, as we have been doing hitherto, all those matters, considerations, human attitudes, which generally go under the headings, 'religion' and 'morality', our scientific endeavours to remedy the existing evils and put things straight may not come up to the expectations that people entertain regarding science as one of the most potent instruments in the fight against evil and for the increase of human welfare.

Obviously one cannot adduce scientific evidence in support of the above-mentioned statement that science is likely to fall short of its expectations. For one thing 'religion', 'morality', 'things of the spirit' are words and expressions lacking in the type of definition and precision of meaning with which students of science are familiar. But since the advent of our scientific age, and as some thoughtful people believe partly because of it, events have happened in human societies, which should give sufficient reason to us, men and women trained in the methods of science, to examine anew our conceptions of religion and morality and all that they signify in the affairs of man.

The agnostic, non-committal attitude of the generality of men of science of the past and the present towards the questions is well known and easily understandable on intellectual grounds. It was and it is to a degree justifiable in view of their avowed profession. But it is conceivable that they may have blundered consciously or unconsciously in extending this agnostic, noncommittal attitude of 'scientific materialism' of the laboratory to the outside, to their philosophy of life and in the world affairs. And it is also conceivable that in view of the increasing prestige of science in the last one or two generations, the repercussions of this indifferent mental attitude towards discussions of religion and morality in the world outside might have been greater than men of science imagine. This attitude, being easier to understand and maintain, might have almost imperceptibly permeated to a considerable extent the minds of the non-scientific intelligentsia all the world over. We are perhaps too near the events to assess rightly to what extent for good or evil, this negative, indifferent attitude towards religion and morality influenced the economic, political and social relations of men during recent times. But there is a considerable body of thoughtful men, including a few professional scientists, who have been saying for the past several years that this indifferent attitude, engendered and fostered by scientific materialism as its philosophy, is not so tenable as it was supposed. And there may be some truth in the indictment that though science indirectly helped to destroy effectively many superstitions and harmful practices going as religion and morality, it may have come in the way of spreading righteousness and goodwill among men by maintaining an indifferent attitude towards religion and thus lessening its emotional drive and influence for the good of mankind fostered by feelings of sacredness and righteousness.

An Idea of God

Recent investigations by several eminent men of science in Physics, Chemistry and Biology have thrown a new light on our conceptions of matter, space and time. Readers of this Journal are all familiar with these remarkable researches taking place on the frontiers of these branches of natural science, bringing their far-flung boundaries closer to one another every day. They all point to a great generalization, which is slowly emerging. That behind this external separateness, at the back of this variety and diversity of phenomena that men of science are studying there lies a basic, fundamental unity, admittedly difficult to conceive and define. Some of these fundamental researches of men of science are highly suggestive. They warrant a justifiable inference that the different phenomena that the biologists, chemists and physicists are investigating in their respective fields may really

be materialized expressions, outward manifestations of some fundamentally unique, still mysterious agency, difficult to grasp intellectually, difficult to put into words and to be communicated, but perhaps lying within the ambit of individual human experience.

One of the basic sciences, a more or less exact science such as Physics, postulates, as we all know, on grounds which are sound and scientific an underlying *'relation'* a sort of *'connection'* between the 'observed' and the 'observer', between the phenomenon and its investigator. It is true that the exact nature of this relation at present eludes us. But bearing in mind these scientific considerations would it be too big a jump, even on intellectual grounds, shall we be accused of forsaking reason, if we infer that the observed and the observer, the experienced and the experiencer are so-called material expressions, the manifestations of some agency, fundamentally unique, whose creations they are?

This 'One' in all may conceivably serve us as our conception of God, even as a hypothesis to be experienced and realized, God in Whom the ideas 'I' and *'not-I'* or *'the other'*, the idea of *'self'* and *'not self'* lose their separateness and distinction and merge into 'One'.

If our fellow-workers in science, at least in India, can feel no intellectual compunction to subscribe to such ideas, they will only be paying well-merited homage to those great thinkers of our ancient land whose magnificent efforts had almost reached the farthest limits of human intellect and will.

Mind, Spirit, Soul

That these terms and the conceptions they engender lack definition and precision of scientific terminology and thought is a matter of common knowledge. How inadequately they have been defined and explained in other words in standard dictionaries can be easily ascertained. And yet it is equally well known what an important part human activities associated with these words have played in the career of man on this planet. Students of science of course know this. But as regards the existence and nature of mind are not our views coloured by scientific materialism? If one mistakes not, orthodox science believes that mind can only exist in association with animal body, being an integrated function of a system of organs, the nervous system. Science is not prepared to give any countenance to the statement that mind activities normally associated with a living human body may be manifested otherwise.

But in view of some experimental work which is being carried out on truly scientific lines of telepathy and clairvoyance, under the general name Extra Sensory Perception (E.S.P.), and on telekinesis, etc., at Duke University, North Carolina, U.S.A., by J. B. Rhine and his associates[1] and also in Great Britain[2] we may have to revise some of our ideas regarding mind. This kind of work on scientific lines lends support to some of the most remarkable findings recorded in the *Proceedings of the Society for Psychical Research (London)*, and to the pronouncements and opinions of eminent philosophers and writers like Professor B. L. Atreya[3] and Professor C. L. Reiser[4], and Pandit D. V. Gundappa[5]. In this connection it is also interesting to quote the great historian of science, Charles Singer[6]. At the end of the last paragraph concluding his book, he says: "Notably it seems probable that the conceptions of the separation of mind from mind and of mind from matter may need modification. There are many indications that the tendencies of science since the later nineteenth century have been working in these directions."

Religion as the Basis of Morality

Attempts are being made to define moral and immoral acts and find justification and sanction for morality on intellectual grounds and on the findings of science. That it is difficult to divorce morality from intellect and reason, which science constantly uses, will be granted at once. Few will dispute that knowledge is necessary to calculate and weigh the consequences of our acts and to arrive at judgments. As scientific knowledge of the conditions amidst which men behave is reliable, science can help in this direction.

But is it all a matter of knowledge, of scientific knowledge? Do people always act in the way of what they call morality by weighing the consequences of their acts? What of the behaviour of large masses of people, for instance in England and Russia, in times of crisis, which change the course of history, such as the present war? May we ask, whether material considerations alone sustained some of these people in their darkest hour and made them put forth their mightiest effort when unheard of destruction, total defeat and disaster were staring them in the face. It is probable that many of them, if not all, *felt* that a certain course of action on the part of a nation, as in the case of an individual was *implicitly* unrighteous and immoral, and they reacted. It is conceivable that reason and weighing of consequences alone could not have driven many of them to make the supreme sacrifice. The righteous resolve may have been engendered by *feeling* and sustained by *faith*. They felt and experienced certain values. It seems then that feeling and faith may yet be counting a great deal in the affairs of morality.

But it may be asked where comes in religion here, which has been such a fruitful source of misunderstanding and disharmony among men. Could not all that has been said above go under 'Scientific Humanism'?

One feels that a good reason may be given for putting the new wine—the scientific understanding of man, nature and God—in the old bottle, religion. Common people, educated, but not well versed in the way science tackles problems, will feel heartened when they are told that in matters of morality, which are intimately connected with religion as it is understood by ordinary people, science is not in a position to put *feelings* and *faith* out of court altogether. The statement that intellectual considerations alone do not induce men to perform moral acts will strengthen the faith of the common men in many of the sayings of the great prophets and seers with which science can have no quarrel.

And we, students of science, on our part lose nothing; we shall not be committing any intellectual 'Harakari' if we grant the hypothesis that those great prophets and seers had seen farther in their own way in these matters of religion and morality. As regards their conception of God it is conceivable that they may have felt more intensely the presence of some unique agency, the unity underlying the diversity of phenomena, that men of science are unravelling to-day. They have proclaimed in no uncertain terms that man can aspire to realize 'One' in all. They saw the same face in the myriads of faces animate and inanimate.

And finally, it may be that the great justification of science, the true philosophy, is yet to come. The present-day scientist, the devotee of the external, soul bewildering frills and frescoes of the outer temple may some day find unimaginable peace and harmony by withdrawing in the inner temple of the soul where all is one, heartily subscribing to the truth and utility of the profound adage, 'Do unto others as you would have them do to you'.

1. "Address, the Parapsychology Laboratory, College Station, Durham, North Carolina, U.S.A.," *The Journal of Parapsychology*. 2. Soal, S. G., & Goldney, K. M., "Experiments in Precognitive Telepathy," *Proceedings of the Society for Psychical Research*, Parts 1 and 2, December 1943. Review in *Nature*, No. 3880 of 11th March 1944, by E. J. Dingwall. 3. Atreya, B. L., "Supernormal Factors in Human Personality," Presidential Address (Section of Psychology and Educational Science), 30th Indian Science Congress, Calcutta," 1943. 4. Oliver L. Reiser, "Humanism and the World Mind," *The South Atlantic Quarterly*, 1939, **38**, No. 2, April. 5. (*a*) Gundappa, D. V., "Science and Ethics," *Current Science*, December 1941, **10**, No. 12; (*b*) Gundappa, D. V., "Towards a New World Order, An Indian View," An Address delivered to the Joint Easter Session of Science Associations in Bangalore, India, April 1942. 6. *A Short History of Science to the Nineteenth Century*, 1941. (Charles Singer, Publ. Oxford, at the Clarendon Press.)

THE APPLICATION OF INFRA-RED SPECTRA TO CHEMICAL PROBLEMS*

APPLICATIONS of spectroscopy in different directions have been the subject of so many conferences on the subject that Professor Mulliken in opening the conference on spectroscopy in 1942 remarked, "Less attention has been given lately to spectroscopy as a pure science ..... It seems to us that the pure science aspects of spectroscopy deserved new emphasis." In the case of infra-red spectroscopy, however, difficulties confronting the investigator have been such that the number of votaries have been relatively small and the report under review represents one of the few conferences that have been specially devoted to this part of the subject. The collection of papers here constitutes a welcome report of the present position of the subject, though it represents essentially the contributions of the British school of workers from Oxford and Cambridge, an isolation presumably due to the difficulties of war time.

As one peruses the different papers, Professor Rideal's introductory remark, "It is one of the difficulties inherent in war-time that the Secrecy Act intervenes with different degrees of rigour in the various nations. Here, in this country much work in the field of infra-red spectroscopy has still to be withheld from publication. Our Trans-Atlantic cousins are more fortunate in this respect" constantly occurs to one's mind and it is to be hoped that the Faraday Society will soon have a fuller discussion on the subject.

The report falls naturally into two divisions, the first part dealing with experimental technique and the second with applications to different chemical problems. A brief review by Drs. Sutherland and Thompson on recent developments and present position of spectrometers, optical systems, calibration, detection and recording of infra-red spectra begins the series. This is followed by a useful note on sources of radiation and the preparation of absorption cells and another on accurate measurement of cell thickness. The very brief contribution on solvents gives no doubt valuable information but one cannot help commenting on its laconic character. The time-saving device described by Willis and Philpotts for making hand-operated spectrometers automatic and Dr. Conn's Thermocouple Bolometer detector fill an important need and the increased speed for a given sensitivity should remove one of the disadvantages of infra-red and lead to a larger volume of work.

The greater part of the discussion is devoted to the second section referred to earlier. The value of infra-red spectra lies in the principle that except optical isomers, no two molecules can have an identical array of frequencies and the improved techniques have made it speedier. The principal obstacles in the way have been the difficulties in detecting, recording and computing accurately. An introductory note discussing these is followed by examples of typical analyses of closely related organic compounds, usually of common occurrence, and the report presented bears out clearly the advantanges of this tool.

A critical analysis of available experimental evidence leads Dr. Simpson to a new assignment of the fundamental frequencies of the ozone molecule. While due note is taken in making the assignments of the contour relationships, intensities, and probable values of the force constants, both the paper and the discussion thereon point to the necessity of reinvestigation of both electron diffraction and infra-red results. The paucity of the Raman

* *Transactions of the Faraday Society*, 1945, **41**, 171–297. Report of a discussion held on 2nd January 1945. Price 15*s*. (Messrs. Gurney & Jackoon, London.)

spectra studies is quite noticeable, the only reported investigation being that of Sutherland and work on this also should lead to more valuable data for a correct assignment of frequencies. Still, the essential features of the structure of the ozone molecule may not be altered. In deciding on the possible contributing structures, however, the magnetic susceptibility value cannot rule out structures II and VI (p. 210), the observed feeble diamagnetism being of the right order of magnitude if these structures are also taken into account.

Of considerable interest to the chemist is information concerning the carbon-carbon bond and the bonds between hydrogen and the elements of the first short period. Bartholomè and Teller have shown that C-C vibrations lie between 809 and 1143 cm.$^{-1}$ but this region sometimes involves overlapping with the C-H bending vibrations. Using Teller's method for a system of mass points in one plane, Kellner has found a remarkable agreement between his calculated and observed values of frequencies for open chain and alicyclic hydrocarbons as well as for various degrees of branching in the chains. There are, however, a number of instances where the frequencies given as "observed" by Kellner differ from those values reported by other authors and these other values bring out discrepancies. This only shows the limitations of any oversimplified method of approach as is the case here but the approach is none the less useful.

Linnett's evaluation of the force constants leads to a number of interesting results with the C-H bond. Abnormal values are obtained in the case of saturated hydrocarbons of the aliphatic series and their derivatives, whenever a resonance hybrid structure involving ionic structures is possible, as, for example, methyl fluoride and diphenylmethane. The special behaviour of the first member of a homologous series is noticeable here too. The change from these saturated aliphatic structures to olefinic or benzenoid structures leads to an increase in the force constant which becomes still higher for the C-H bond in acetylenes. This leads to the surprising result that the strength of the bonds increases as the proportion of s-orbital in the hybrid bond increases. It is well known that the ease of hydrogen replacement by metals increases as one changes from saturated to acetylenic hydrocarbons and both phenomena have apparently the same explanation: that ionic structures with hydrogen positive make appreciable contribution to the hybrid form. As Higgins has pointed out, the same explanation is possible for the higher force constant in nitromethane. The presence of an aldehydic group also alters the force constant appreciably, in this case a decrease which is quite marked. Using the Douglas Clark relation and the value of the force constants calculated, values of bond lengths have been obtained which agree reasonably well with observed values.

The calculations also bring out the periodicity in the M-H link (M being any element of the III to VII groups). The value of the force constant for the bond between hydrogen and a member of the first short period appears to bear a constant ratio to that of a bond between hydrogen and the corresponding member of the second short period. These generalisations obtained by the use of a drastically simplified potential field has to be treated with some reserve, as other factors also influence the force constant and may not be negligible in all cases. The results are, however, quite useful in correlating approximately the different properties of the bonds in question.

Dr. Sutherland has reported the results of a fresh investigation on the infra-red spectrum of the diamond. "Type II" diamonds are found to exhibit the peculiarity that transmission over the whole range of spectrum investigated was poor with a complete blackout in the region 4·5 to 5 μ. "Type I" diamonds which may all be expected to behave alike, however, show very definite differences as may be noticed from the diagram on p. 290. This difference in behaviour among "Type I" diamonds is noticeable also in ultra-violet absorption. Obviously, a division of diamonds into just two classes is not adequate for a proper classification. While the prominent infra-red absorption bands remain to be explained, the mass of experimental evidence on which Raman has based his theory, makes it a better approximation to truth. As Sutherland suggests, more experimental work in the infra-red is needed and existing discrepancies between theory and experiment have to be accounted for.

The last contribution to the discussion is a brief note by Bell in which by taking a reasonable physical picture of the torsional potential energy, an agreement as good as those with planar vibrations is obtained for the bond torsion.

A group of three papers deal with topics of considerable technical interest. They present a useful account of the technique for the investigation of substances with high molecular weights and indicate means for the standardisation as well as for following the course of polymerisation or vulcanisation of rubber. The report on coal and coal extracts is enough to indicate the usefulness of infra-red spectra in the study of different grades of coal.

The collection of papers in this number lives up to the level aimed at in Discussions of the Faraday Society and should find a place in any library, academic or technological.

S. V. ANANTAKRISHNAN.

OBITUARY

DR. HEMENDRA KUMAR SEN

BY the death of Hemendra Kumar Sen at the comparatively early age of fifty-six, India has lost one of her foremost men of science whos econtributions to chemistry, both pure and applied, have been many and varied and whose name and fame as a teacher of chemistry had spread throughout the length and breadth of this sub-continent.

Sen was born at Noorpur, district Faridpore, on the 24th of December 1889. His ancestral home was at Baldhara in the Dacca district. He had his early education at Brahmanbaria, where his father, the late Prasannakumar Sen, was a Deputy Inspector of Schools. After passing the Entrance examination in 1904, he came to Calcutta and joined the City College and here he met his life-long friend, Dr. Bimanbehari Dey, now Director of Public Instruction, Madras.

After graduation in 1908, Sen joined the M.A. classes in chemistry at the Presidency College, Calcutta. Here he came under the influence of the late Sir P. C. Ray who, as is well known, had an almost uncanny instinct for detecting latent merit. He took very kindly to the young student and the latter in his turn cherished a life-long warm affection akin almost to filial piety, for his revered *Guru*.

Sen appeared in the M.A. examination in 1910 but by a cruel irony of fate, failed in the practical examination as he could not carry out a complete analysis of type metal in course of a single day! He passed with a First Class in 1911 and secured in the following year the Premchand Roychand Studentship, the highest distinction to which an Indian student can aspire.

During his college days, Sen had a hard and bitter struggle with poverty. He used to maintain himself by giving private lessons and for some time even lived with Sir P. C. Ray in his former residence at the office and factory of the Bengal Chemical and Pharmaceutical Works, Ltd., at 91, Upper Circular Road, adjoining the compound of the present University College of Science. He had only a single change of clothing at the time and he made his books do duty as pillow by night. Sen was never tired of relating that when Sir P. C. Ray came to know that he was finding it difficult to raise the modest sum of rupees thirty-two, the fees for the Premchand Roychand Studentship examination, he paid the sum himself unasked.

In 1912, Sen proceeded to England to join the Imperial College, London, and here he devoted himself wholeheartedly to Organic Chemistry. It may be mentioned in passing that Sen was extraordinarily versatile. He was at home alike in the domains of Organic, Inorganic and Physical Chemistry and also one of the pioneers of Bio-chemical studies in India. His earliest contribution to chemical literature was a paper, jointly with Dey, on the estimation of nitrite nitrogen by the action of hydrazine sulphate (*Zeitsch. Anorg. Chem.*, 1911, 71, 236). While working at the Imperial College under the late Professor Jocelyn Thorpe, he published a paper on the condensation of ketones with phenols (*J.C.S.*, 1914, **105**, 339) and another on the formation of heterocyclic compounds from cyanacetamide and hydroxymethylene-ketones (*J.C.S.*, 1915, **107**, 1347). The second paper, which formed part of his thesis for the Doctorate in Science of the University of London, contained an elegant method for the synthesis of quinoline derivatives, which has found its way into standard text-books on Organic Chemistry like Meyer-Jacobson. He was using the surname Sen-Gupta at the time.

Sen returned to India in 1915 and in 1916 he joined the Tata Iron and Steel Works at Sakchi where, however, he spent only a few months. Later, he proceeded to Rangoon and worked for some time as the Chief Chemist at the chemical works of Messrs. Jamal Brothers and subsequently at the chemical works of De Souza and Company. At Rangoon he met his future wife Miss Kalpanarani Sen, daughter of the late Mr. N. C. Sen and grand-daughter of the late poet Nabin Chandra Sen, whose name is a household word in Bengal. The marriage was solemnised in 1917 but in 1920, after only three years of a very happy married life, Mrs. Sen died in child-bed.

Life at Rangoon became distasteful after this sad event so that when the late Sir Asutosh Mukherjee offered Sen the newly created chair of Applied Chemistry and called upon him to organise the department, he readily agreed. He joined the University College of Science in 1920 and it was only then that I came to know him though I had met him casually once or twice before his departure for Rangoon.

At the College of Science, where Sen spent sixteen best years of his life, he applied himself to his task with zeal and a singular devotion which stands unparalleled in the history of this Institution. He used to work long hours and often late into the night. No wonder that within a short time he gathered round himself a band of enthusiastic and devoted students, many of whom are now filling responsible positions very creditably.

Sen was by nature impetuous and he had a hearty disregard of red-tape, especially in matters appertaining to his own department. As a consequence, he had occasional clashes about questions of procedure with the University authorities. The latter, however, were always ready to stretch a point in his favour and overlook the irregularities which became less and less frequent as years rolled on.

In the lecture hall also Sen was unconventional, delivering his class lectures scarcely according to the prescribed routine and very often prolonging the period to two or even three hours. But as the lectures were prepared with meticulous care and contained a wealth of information and were enlivened with anecdotes, they seldom failed to interest the most listless of backbench men. It may be said without exaggeration that Sen was easily

the best speaker on scientific subjects of his time.

In 1922 Sen went to Berlin as Sir Rashbehary Ghosh Travelling Fellow and joined the laboratory of Neuberg at the Kaiser Wilhelm Institut at Dahlem and on his return the following year, he turned his attention to biochemical problems, specially those relating to fermentation. He was a firm believer in the possibility of the extermination of the water hyacinth pest by its biochemical utilisation as a source of power alcohol as well as of potash salts and he devoted many years of patient labour to this problem. It is interesting to note that the very first paper in the *Journal of the Indian Chemical Society*, started in 1924, was one by Sen "on the reduction of unsymmetrical dichlor-acetone by yeast".

Problems relating to the generation and maintenance of high temperatures also occupied much of his time throughout the Science College period. In 1927, he was invited by the University of Patna to deliver a course of Sukhraj Rai Readership lectures. The subject he chose was "High temperature flames and their thermodynamics". The lectures were subsequently published in the form of a book which was 'dedicated to the sacred memory of the late Sir Asutosh Mukherjee, the originator of the Post-Graduate system of studies in the University of Calcutta'.

Sen was particularly interested in glass furnaces and experimented with different types of furnaces as well as burners for atomised liquid fuel, as a result of which, a combination was evolved which appeared to be very promising. With a view to give the system a trial on a manufacturing scale, Sen undertook upon himself heavy financial liabilities by starting a glass factory in the outskirts of Calcutta. Unfortunately, it could not be run properly due to various causes, the chief being the want of sufficient working capital. He lost very heavily and the financial worries consequent thereon continued to trouble him all his life and probably hastened the end.

In 1930, he went to Germany for the second time to attend the World Power Conference at Berlin. It was on this occasion that he met Fraulein Fritzi Emich, a daughter of Professor Emich of Graz, Austria. The acquaintance gradually ripened into love. They were married when Sen went to Germany for the third time in 1933.

Attendance at the World Power Conference brought in its train researches on high pressure electrolysis for which elaborate arrangements were made in the workshops of the applied chemistry department. The researches on biochemical problems were also continued with unabated vigour and a new problem—the low temperature carbonisation of Indian coals—was now added to his repertoire. Sen had a firm faith in the efficacy of always having more than one iron in the fire and acted fully upto it.

In 1936 Sen left the College of Science to join his new post as the Director of the Lac Research Institute at Namkum, Ranchi, and remained there for eight years. After the tumult and bustle of Calcutta, Namkum with its absolute quiet, splendid scenery and vast expanse of field and forest gave Sen the rest and repose that he so sorely needed. Under his able guidance, the Lac Institute whose name as a place of active research was practically unknown even to most of the residents of Ranchi itself, lying five miles away, soon became a centre of vigorous research activity, particularly in the domain of plastics.

Namkum also exercised considerable influence on his character and made him more thoughtful, less impetuous and even more lovable if that could be possible. The people of Ranchi idolised him and he was always sure of a warm welcome wherever he went.

Last year he was prevailed upon by the Government of Bihar to accept the post of Director of Industries. Big schemes of post-war reconstruction, for framing some of which Sen was personally responsible, were in the offing and although the strain of the past few years was beginning to tell on his health, he considered it his duty to shoulder the heavy burden. His new duties combined a large volume of routine office-work with frequent tours, and his friends soon perceived alarming signs of rapid deterioration of his health. In October last when Sen was in Calcutta on a short visit, all his friends advised him to apply for leave and take some rest but this he left unheeded. On the 7th of December he came to Calcutta to solemnise the marriage of his son but soon after his arrival, he had a serious breakdown. He had to take to his bed immediately but the best efforts of his friends and relatives were of no avail. He died on the 3rd of June 1945.

The death of Hemendrakumar Sen has left a void in the scientific life of India, which it will be difficult to fill. He was one of the Foundation Members of the Indian Chemical Society, of which he was elected President in 1940. He founded the Indian Institute of Chemistry and was its President on two occasions. He was also one of the Foundation Members of the National Institute of Sciences of India. He served on innumerable committees, both of the Government of India and the local Governments, and his advice was eagerly sought for not only by his brother scientists but also by businessmen and industrialists. In the Indian Science Congress, over the Chemistry Section of which he presided in 1927, Sen was a very popular figure. The discussions in which he took part were always lively while his popular lectures always attracted a full house.

Sen was by nature thoroughly democratic and his intimate friends included many in humbler walks of life. His memory will be long cherished as a treasure by his pupils, relatives and friends.

P. C. MITTER.

LETTERS TO THE EDITOR

ON THE DESIGN OF EXPERIMENTS FOR WEIGHING AND OTHER TYPES OF MEASUREMENTS

Whilst the theory of the design of experiments as applied to biological investigations in general and agronomic investigations in particular has now reached an advanced stage of development, largely as a result of the work of the Fisherian and the Calcutta schools of statistical workers, the theory as applied to weighing and other types of physical measurements for getting efficient estimates of p given unknowns has only recently begun to be developed. The basic principles of this theory are set forth in a recent paper by Hotelling[1] in which the author has called attention to the need for further mathematical research for obtaining a comprehensive general design. I have been able to obtain such a design in case the number of weighings N is at our choice and have also worked out other general designs for specified values of N and p.

2. Using Hotelling's notation, we may write

$$E(y_\alpha) = \sum_{i=1}^{p} x_{i\alpha} b_i,$$

where $i = 1, 2, \ldots\ldots p$ on the assumption that there is either zero bias in the scale or the bias is known *a priori*, and $\alpha = 1, 2, \ldots\ldots N$. Here $x_{i\alpha} = 1$ or -1 according as the αth weighing includes the ith object in the left or right-hand pan, b_i is the true unknown weight of the ith object, y_α the actual result of the αth weighing and $E(y_\alpha)$ its expectation. For a biassed scale, we may take $i = 0, 1, 2, \ldots\ldots p$, the bias being b_0 and $x_{0\alpha} = 1$.

Assuming that $y_1, y_2, \ldots\ldots y_N$ are uncorrelated and have a common variance σ^2, it follows from the theory of linear estimation as developed by Bose[2] and Rao[3] that the normal equations giving the best linear estimates of the b_i's are

$$X'XB' = X'Y',$$

where X is the matrix $[x_{i\alpha}]$, B the row vector $[b_1 b_2 \ldots b_p]$, Y the stochastic vector $[y_1 a y_2 \ldots y_N]$, and X′, B′ and Y′ denote as usual the transpose of X, B and Y respectively.

Let $C = [c_{ij}]$ denote the reciprocal of the matrix X′X so that the variance of the best linear estimate of b_i is $\sigma^2 c_{ii}$. Then the mean variance of the p unknowns for a design is given by

$$V_m = \frac{\sigma^2}{N} \cdot \frac{N \sum_{i=1}^{p} c_{ii}}{p}.$$

If the main object of the experiment is the estimation of the unknowns with the least variance, the most efficient design (for a specified value of N) would be the one for which the *minimum minimorum* of $\frac{\sigma^2}{N}$ is attained for all the p unknowns. The quantity $\frac{p}{N \sum_{i=1}^{p} c_{ii}}$ may, therefore, be defined as the *efficiency* of a given design for providing the estimates of the p unknowns. I have used this quantity for judging the precision of the designs I have obtained.

3. By utilizing the properties of a 2-sided m-fold completely orthogonalized Hyper-Græco-Latin hyper-cube of the *first* order introduced earlier,[4] I have constructed a completely orthogonalized design for $N=2^m$, $p \leqslant 2^m$ (zero bias) or $p \leqslant 2^m - 1$ (non-zero bias), m being any positive integer, by which each unknown is estimated with the minimum variance $\frac{\sigma^2}{N}$, and thus its efficiency is 100 per cent.

For $N=2^m+1$, $p \leqslant 2^m$ (zero bias) or $p \leqslant 2^m-1$ (non-zero bias), m being any positive integer, I have obtained two types of designs. The efficiency of the first design for which

$$X'X = \begin{bmatrix} N & 1 & 1 \ldots. 1 \\ 1 & N & 1 \ldots. 1 \\ 1 & 1 & N \ldots. 1 \\ \multicolumn{3}{c}{\ldots\ldots\ldots\ldots\ldots\ldots} \\ 1 & 1 & 1 \ldots. N \end{bmatrix},$$

the order of the matrix being $p \times p$ if there is zero bias, or $(p+1) \times (p+1)$ if there is bias, comes out to be

$$1 - \frac{p-1}{N(N+p-2)} \text{ for zero bias,}$$

or $$1 - \frac{p}{N(N+p-1)} \text{ for non-zero bias.}$$

It is surmised that this is probably the most efficient design available for these values of N and p. For the second design, the efficiency is $\frac{(N-1)p}{Np-1}$ for zero bias, or $\frac{N-1}{N}$ for non-zero basis.

For $N = 2^m + r$, $p \leqslant 2^m$ (zero bias) or $p \leqslant 2^m - 1$ (non-zero bias), r being any positive integer $< 2^m$ and m any positive integer, I have worked out two designs, which are exact analogues of the two designs just discussed. For the first design of this type, the efficiency is

$$1 - \frac{(p-1)r^2}{N[N+(p-2)r]} \text{ for zero bias, and}$$

$$1 - \frac{pr^2}{N[N+(p-1)r]} \text{ for non-zero bias.}$$

For the second design of this type, the efficiency comes to be $\frac{(N-r)p}{Np-r}$ if there is zero bias, and $\frac{N-r}{N}$ if bias is present.

Finally, when N is at our choice, we can always obtain a completely orthogonalized design by taking N equal to a sufficiently large power of 2.

A short paper giving details of these results has been sent to Prof. Harold Hotelling and is likely to be published in the *Annals of Mathematical Statistics*.

Dept. of Agriculture, U.P.,
Lucknow, K. KISHEN.
May 31, 1945.

1. Harold Hotelling, "Some Improvements in Weighing and other Experimental Techniques," *Annals of Mathematical Statistics*, 1944, **15**, 297–306. 2. Bose, R. C., "The fundamental theorem of linear estimation," *Proceedings of the Thirty-first Indian Science Congress*, 1944, Part 3. 3. Radhakrishna Rao, C., "On Linear Estimation and Testing of Hypothesis," *Current Science*, 1944, **13**, 154–155. 4. Kishen, K., "On Latin and Hyper-Græco-Latin Cubes and Hypercubes," *Current Science*, 1942, **11**, 98–99.

D.C.-A.C. VIBRO CONVERTER (50 C.P.S.)

A VIBRO converter unit has been designed and developed at the Department of Electrical Technology of the Indian Institute of Science, Bangalore, during 1944-45 on new lines and using indigenous materials. It converts 110/220 volts D.C. (mains supply) to 110/220 volts A.C. of square topped wave form (fundamental frequency of 50 cycles/sec.). Many difficult problems like the selection of proper contact material, the determination of the suitable make to break time ratio, the suppression of high voltage surge in the transformer secondary, etc., have been solved to make the design successful. The efficiency of the machine increases with the increase of load from 50 to 75 per cent., and the vibro converter is capable of supplying current up to 2 amps. with a voltage regulation of 3 to 4 per cent. Full details of the machine will be published elsewhere.

Research Assistant,
Dept. of Electrical Technology,
Indian Institute of Science,
Bangalore, R. N. DEWAN.
August 6, 1945.

MAGNETIC ANISOTROPY OF IODINE CRYSTAL

INFORMATION regarding the magnetic anisotropy of crystals of non metallic elements is scanty. In the case of metals, studies of the magnetic properties of crystals have been possible since large cylindrical crystals can be grown by the method of slow cooling. But with non metallic elements such methods are not applicable. Other lines of approach have to be considered.

One such method is the critical torsion method developed by Krishnan.[1] Small crystals can be employed and using fine quartz fibres, the magnetic anisotropy of any crystal can be accurately determined. Krishnan's method has been found to be successful in the case of elements as evidenced by the work of John[2] and Rao.[3]

In the case of iodine, Krishnan's method is ideal. Resublimed iodine crystals, having masses of about 100 mg., were employed. Test experiments proved that the specimen of iodine was free from any ferromagnetic impurity. Investigations on critical torsion were

made at field strengths of 8,000 oersteds. Fine quartz fibres were used, their torsion constants being determined by separate oscillation experiments.

Iodine crystallizes in the orthorhombic system.[4] Molecules of I_2 have their axes on the *ac* plane, these axes making angles of $+\phi$ or $-\phi$ with the *a*-axis. The atoms in an iodine molecule are 2·70 A apart. Between neighbouring molecules, the separation is 3·54 A in the *ac* plane and 4·35 A in adjacent planes. Cleavage takes place, therefore, easily along the *ac* plane.

With the cleavage face of an iodine crystal horizontal, it is easy to locate the *a* and *c*-axes. Investigations on five crystals gave the following average values for the principal specific susceptibilities.*

$\chi_a = -0·354$, $\chi_b = -0·331$ and $\chi_c = -0·366$.

Since the iodine molecules lie in the *ac* plane, the specific susceptibility normal to the axis of the molecule becomes χ_b. With this simplifying assumption a calculation of the specific susceptibilities of the iodine molecule parallel and perpendicular to the axis, gives $\chi_{\parallel} = -0·389$ and $\chi_{\perp} = -0·331$. The corresponding gram molecular susceptibilities are 98·74 and 84·03 respectively. The angle ϕ works to 51°. The axes of the iodine molecules in the crystal are thus found to be inclined to the *a*-axis of the crystal at angles of $+51°$ or $-51°$. The available X-ray data do not appear to be specific on this issue.

Department of Physics,
Central College,
Bangalore,
July 10, 1945.
S. RAMACHANDRA RAO.
H. S. VENKATARAMIAH.

1. *Phil. Trans. Roy. Soc.*, 1935, **A 234**, 265. 2. *Zeits. Krist.*, 1939, **101**, 337. 3. *Jour. Mysore Univ.*, 1945, **5**, 69. 4. Wyckoff, *The Structure of Molecules*, 1931, p. 210.

* The susceptibility values are given in 10^{-6} unit.

'KYANOPHYLITE'—A NEW MINERAL OF THE HYDROUS ALUMINIUM SILICATE GROUP, DERIVED FROM KYANITE, FROM MAVINHALLI, MYSORE

ABOUT a mile and a half W.S.W. of Mavinhalli, in the ground consisting of the composite series of kyanite graphite schists, talc biotite schists, sillimanite quartz schists and other types of granulitic rocks, are found some loose bits and small lumps of an apple-green mineral which looks like some variety of talc or chlorites. It is, however, much harder than any of these minerals, and contains a large percentage of alumina and practically no magnesia at all. On chemical analysis, one of the specimens gave the following percentages:—

SiO_2–45·20; Al_2O_3–41·04; CaO·3·72; MgO–0·0; K_2O–0·73; Na_2O–3·84; Loss on ignition (mostly H_2O)–5·00.

The data show that it is essentially a hydrous aluminium silicate.

In thin sections the mineral forms feather-like aggregates, and shows fairly low refraction (about 1·58 to 1·60) and low birefringence,—the interference tints being low greys and hardly rising above yellow and red of the first order. In its physical and optical properties it does not correspond to any of the known varieties of the group of hydrous aluminium silicate minerals. The mineral forms a new type possessing its own individual characters, and will be described in detail in the next volume (XLIII) of the *Records of the Mysore Geological Department*.

Mysore Geological Dept.,
Bangalore,
May 23, 1945.
B. RAMA RAO.

MIXTURES OF TETRYL AND T.N.T.

ACCORDING to Giua,[1] and Taylor and Rinkenbach,[2] tetryl (trinitrophenylmethylnitramine) and T.N.T. form a compound which melts at 67·6° C. and which contains the tetryl and the T.N.T. in the molecular proportion 1 : 2 respectively. Their conclusion is based on the presence of a very flat maximum in the melting-point diagram for tetryl/T.N.T. mixtures at a point which corresponds to the above proportions and melting-point. Efremov and Tikhomirova,[3] using a similar technique, reported that they could find no evidence for the existence of a compound.

As an alternative method of investigation we have determined the molecular weight of the alleged compound by measuring the depression of the freezing-point produced when it is dissolved in benzene. With three separate samples, prepared by melting the tetryl (m.p. 129·1° C.) and T.N.T. (m.p. 80·3° C.) together, figures of 233, 232 and 233 were obtained taking 51·2° C. as the molecular depression for benzene. These figures are, approximately, what would be expected from a mixture. The compound would have a molecular weight of 741.

In addition, it is possible to separate the tetryl and the T.N.T. by treatment with carbon tetrachloride at 0° C.[4]

Clearly, then, tetryl and T.N.T. in the molecular ratio 1 : 2 do not behave as a compound in solution at about 0-5° C.

We wish to thank the Director of Armaments for permission to publish this observation.

Inspectorate of Military
Explosives, Kirkee,
May 24, 1945.
M. D. OWEN.
J. VERGHESE.

1. Giua, *Gaz. Chim. Ital.*, 1915, 45, **2**, 32. 2. Taylor and Rinkenbach, *Ind. and Eng. Chem.*, 1923, **15**, 73. 3. Efremov and Tikhomirova, *Ann. Inst. Anal. Phys. Chim.*, 1926, **3**, 269–301. 4. Allen's *Commercial Organic Analysis*, **3**, 637.

A CHEMICAL METHOD FOR THE ESTIMATION OF ALKALOIDS PRESENT IN ARGEMONE OIL AND ITS APPLICATION TO A MIXTURE OF ARGEMONE AND MUSTARD OILS

ON account of its supposed role in causing epidemic dropsy argemone oil has received considerable attention in recent years. The theory is that when argemone oil is present in mustard oil as adulterant the ingestion of such mustard oil would produce epidemic dropsy in man. Lal *et al.*[1] were not able to substantiate this theory by isolating any toxic substance from this oil. The present authors[2] have, however, been able to isolate at least two toxic factors of alkaloidal nature from argemone oil. Whether they are responsible

for the development of symptoms of epidemic dropsy in man is a question that can only be settled by further work. The possibility, however, of the presence of toxic substances in edible mustard oil is dangerous from the standpoint of public health and as such attempts should be made to determine as accurately as possible the amount of argemone oil in an adulterated mustard oil sample.

The quantitative nitric acid method proposed by Lal *et al.*[3] for this purpose is not reliable for various reasons, *e.g.*, (*i*) the test is not specific—the colour being given by a number of substances, (*ii*) the supposition that in the case of argemone oil the development of colour is due to a single 'reacting substance' is no longer tenable and (*iii*) the equivalent amount of 'reacting substance' per c.c. of argemone oil as calculated from extinction coefficient data of Lal varies between 2-3 mgm. and this amount in its turn looks quite small in the light of our experience.

Sarkar[4] developed a sensitive chemical test for the detection of argemone oil in adulterated mustard oil samples, the criterion of the positive test being the appearance of beautiful orange-red fibrous crystals. This substance has since been purified and has been found to be the hydrochloride of a nitrogenous base—the formula being $C_{19}H_{15}O_4NCl$. As it was soluble in ordinary solvents it was not suitable for quantitative work for which some insoluble or sparingly soluble derivatives of argemone alkaloids were being sought.

The picrate being practically insoluble in petroleum ether and very slightly soluble in ether was considered to be a suitable compound for the purpose. It was also possible to precipitate the picrate in a very good crystalline form (figure) directly from the oil. Conditions were developed to ensure maximum precipitation of picrates and an outline of the method thus developed is given below.

A known amount of argemone oil is taken in small stoppered flasks to which a definite quantity of acetone, ether and saturated etherial solution of picric acid are added. The flasks containing the mixture are kept aside for about forty-eight hours preferably in a refrigerator. After this, the crystalline picrate precipitate is transferred quantitatively into a weighed sintered glass crucible and then thoroughly washed with petroleum ether and ether (saturated with picrate) to remove oil and excess of picric acid. The crucible is then dried in a steam oven and weighed to constant weight. From this the amount of picrate formed from a known volume of oil can be found out. Taking a particular sample of argemone oil, 1·0 c.c. was equivalent to 10·1, 10·0, 10·1, 10·2 mgms. of picrate. Considering the difficulties associated with the isolation of substances directly from oil no better agreement between the observed values could be expected. Estimations can be carried out accurately with even 0·5 c.c. of argemone oil.

Picrate crystals from argemone oil (Magnified)

The method with practically the same degree of accuracy is applicable to a mixture of argemone and mustard oils. Good results have been obtained even when the percentage of argemone oil was very low—only 5 per cent. There is a point to be noted in this connection which is that in the case of oil-mixtures, a quantity equivalent to 0·5 c.c. of argemone oil should be taken and reagents added proportionately.

Full details will be presented elsewhere.

Our best thanks are due to Professors J. K. Chowdhury, F.N.I., and S. N. Bose, F.N.I., for their kind interest.

Biochemical Laboratory,
University of Dacca, S. N. SARKAR.
May 21, 1945. MD. BAZLUR RAHMAN.

1. Lal *et al.*, *Ind Jour. Med. Res.*, 1941, **29**, 839. 2. Sarkar and Rahman, *Curr. Sci.*, 1945, **14**, 201. 3. Lal *et al.*. *Ind. Jour. Med. Res.*, 1940, **28**, 163. 4. Sarkar, *Ann. Biochem. Exp. Med.*, 1941, **1**, 271.

CHEMICAL EXAMINATION OF *ERYTHRINA INDICA* (WHITE VARIETY)

THERE are two varieties of *Erythrina indica*, the white and the red. The former bears white flowers and yellow seeds. The latter is more common and better known. P. Suryaprakasa Rao and others[1] examined the seeds and bark of *Erythrina indica*. They did not mention whether they worked on the red or white variety. However, the author learnt from them that they examined the red one only. Hence he worked on the seeds of the white variety on precisely the same lines as the above workers.

The seeds of the white variety gave a reddish fixed oil (yield 12 per cent.) on extraction with petroleum ether and evaporation of the solvent from the extract. A comparative statement of the usual constants of the oils from both varieties is given below.

	Oil from white variety (author)	Oil from red variety (P. S. Rao & others)
Specific gravity	0·8603 at 30° C	0·8821 at 30° C
Refractive index	1·4400 at 30° C	1·4596 at 30° C
Saponification value	185·5	184·5
Iodine number	31·84	63·3
Acid number	9·5	1·24

The two oils agree in all properties except the iodine and acid numbers.

The alcohol extract of the oil-free seeds gave a white crystalline alkaloid nitrate. Analysis and study of its properties showed that it was same as hypaphorine nitrate isolated from the red seeds. The two varieties of *Erythrina indica*, therefore, contain the same alkaloid, namely, hypaphorine.

Chemistry Department,
P. R. College,
Cocanada,
May 7, 1945.
J. VIRABHADRA RAO.

1. *Proceedings of the Indian Academy of Sciences* 1938, 179–185.

A NATURAL CONCENTRATE OF VITAMIN A

RAJGOPAL[1] recently reported a very high potency of 1,90,400 I.U./G. (Carr-Price value 3735) for a Sind shark liver oil. No oil of about this potency had been so far extracted in this Presidency. Such a very highly potent oil was extracted recently from livers of very small sharks belonging to *Carcharias* spp. and measuring 1 foot to 1¾ feet and caught on the west coast. Thirty-nine pounds of these livers yielded 12 pounds of oil. Testing the whole oil in a B.D.H. pattern Lovibond Tintometer, a Carr-Price value of 3176 was obtained. Using the factor 54 for conversion of Carr-Price value into international units, as recommended by Rajagopal,[2] the vitamin A potency of this oil can be expressed as 1,71,500 I.U/G.

The oil was further analysed and the following characteristics were recorded:—

Colour	Deep reddish orange
Specific gravity 35°C.	0·9229
Refractive Index 35°C	1·4889
Saponification value	160·7
Iodine value Wijs	144·9
% un-saponifiable matter	18·4
Iodine value of the unsaponifiable matter	302·4

The very high iodine value for the unsaponifiable matter is noteworthy, but was expected from its high content of the unsaturated vitamin A.

It is further difficult to understand the object of such a natural concentrate of vitamin A in such small sharks. In elasmobranchs, perhaps, vitamin A may have some physiological role, as yet unassigned to this nutrient in human metabolism.

Thanks are due to the Director of Industries and Commerce, Madras, for permission to publish this note.

Technical Research Lab.,
Government Oil Factory,
Calicut,
May 1, 1945.
ULLAL SUNDAR KINI.

1. Rajagopal, K., *Curr. Sci.*, 1942, **11**, 52. 2. —, *Ind. J. Med. Res.*, 1941, **29**, 575.

LOBELIA NICOTIANAEFOLIA HEYNE AS SUBSTITUTE FOR *LOBELIA INFLATA* LINN., B.P.

IN connection with the preparation of an 'Indian Pharmacopœial List' which is expected to serve as a Supplement to the British Pharmacopœa in India, work has been undertaken at the Biochemical Standardisation Laboratory of the Government of India to assess critically the 'replacement' value and possibilities of a number of likely Indian substitutes of well-known pharmacopœial drugs. The note given here represents investigations on *L. nicotianæfolia* Heyne as a possible substitute for *L. inflata* of the B.P., a drug fairly extensively used in asthma and similar conditions.

Datta and Bal[1] have already reported on the pharmacognistic characters of *L. nicotianæfolia* and have shown its close resemblance in this respect to *L. inflata*, the official drug. Extensive chemical and clinical trials were, however, called for before adopting the Indian Lobelia as a true, efficient and harmless substitute for the pharmacopœial drug. The chemical investigations carried out in this direction are given below in tabular form. The method of Lynn and Evers[2] was employed, for the estimation of lobeline.

No.	Species of *Lobelia*	Source	Coll. time	Parts used	Tot. alk. as Lobeline	Acid-insol. ash
1	*L. nicotianæfolia*	(*a*) Poona area	Oct.-Nov.	Stems & flowering tops	1·18 %	0·23 %
		(*b*) Do.	Do.	Do.	1·16 %	0·21 %
2	,,	(*a*) Tellichery Madras	Sept.	Flowering tops	1·04 %	1·3 %
3	,,	(*b*) Madras	June-July (during rains)	Aerial parts with flowering tops	0·32 %	0·26 %
4	,,	Not known (recd. through Herbal Herald & Co., Ltd.)	Not known	Do.	0·168%	0·3 %
5	*L. nicot.* (?) (possibly *V. thapsus*).	Not known (recd. through a Cal. firm.	Rainy season	Leaves chiefly	0·105%	0·26 %
6	*L. nicot.* (?) (identified as *V. thapsus*)	South India (recd. through Sepulchre & Co., Cal.)	Not known	Leaves & a few slender twigs	0·117%	0·20 %
7	*L. inflata* (official species)	New York, U.S.A.	Not known	Stems, flowering tops, leaf powder	0·32 %	2·38 %

The table shows conclusively that Indian lobelia, provided it is collected during October-November from suitable areas, is a better substitute than the official B.P. or U.S.P. drug. In a good sample (No. 1*a*, 1*b*), the lobeline content, which is acknowledged to be the chief active ingredient of the drug, is almost four times as high (1·18 per cent.) as an authentic official sample of *L. inflata* obtained from New York through the courtsey of Mr. S. N. Bal, Officer-in-charge of the Industrial Section of the Indian Museum. Samples collected during the rainy season are poorer in alkaloidal content but the lobeline content is still on a *par* with (0·32 per cent.) the average alkaloidal content of *L. inflata*. In certain samples, the lobeline content was found to be as low as 0·117 per cent. Doubt was, therefore, expressed as to whether this sample represented true *L. nicotianæfolia*. Pharmacognostic examination by Indian Museum, Botanical Survey of India, revealed that this sample was from *V. thapsus*, a common adulterant of true lobelia.

From the different parts of the plants (flowering tops, stems, leaves, whole plants, etc.), forwarded to the Laboratory for examination, it appeared that the collectors have hardly any idea as to the part or parts of the plant to be used for pharmaceutical and medicinal purposes. The B.P. 1932 recommends the use of 'dried aerial parts which should not consist of more than 60 per cent. stems'. From differential assay of the various aerial parts of the plant, the following average results were obtained on duplicate analyses of two specimens:

(1) Leaves only—0·64 per cent. lobeline.
(2) Stems only (thin hollow stems, 1-3 cm. diameter)—0·43 per cent. lobeline.
(3) Thick bottom stems—0·21 per cent. lobeline.
(4) Flowering tops only—1·41 per cent. lobeline.

A good sample of Indian lobelia, therefore, should contain chiefly flowering tops and slender top stems and leaves. The thick portion of the stems near the ground (though it is included within the description of 'aerial parts') should be discarded.

For clinical trial, an ethereal tincture was prepared from *L. nicotianæfolia* in the same way as prescribed in the B.P. 1932. By admixture in suitable proportions of Lobelia having higher or lower alkaloidal content or by the addition of exhausted Lobelia, the tincture was adjusted to a lobeline content of 0·3 per cent., more or less the same lobeline content as was obtained from the New York sample of *L. inflata*. This tincture was freely used in 5-15 minim. dosage in simple asthma mixture containing Potassium Iodide and Tincture Belladonna and was found to be quite efficacious and without any untoward effects. A mixture with only Tinct. Lobelia Etheris (from Indian Lobelia) was also used, but this did not prove as effective. This is only to be expected as Tinct. Lobelia acts best as an anti-spasmodic in a synergistic combination with other parasympathetic depressants of the bronchial musculature.

We are, therefore, in a position to recommend the extended use of *L. nicotianæfolia* in place of *L. inflata*, wherever this drug is indicated. *L. nicotianæfolia* should preferably be collected in winter months (October-November) and its thin top stems, leaves and flowering tops should be used as the crude material from which tinctures should be prepared. The liquid preparation should be adjusted to have a lobeline content of 0·3 per cent., and may then be administered in the same dosage as recommended for the 'official' drug in the B.P., 1932.

Biochemical Standardisation Lab.,
Government of India,
110, Chittaranjan Avenue,
Calcutta,
May 25, 1945.

B. Mukerji.
S. K. Ghosh.

1. Datta and Bal, *Science & Culture*, 1944-45, **10**, 260, 2. Lynn and Evers, *Analyst*, 1939, **64**, 381. 3. B. P., 1932, Constable & Co., London, 275.

CONCENTRATION OF RUBBER LATEX BY CREAMING

The concentration of rubber latex by creaming was first noticed by Traube.[1,2] Since then creaming has been used on a large scale in the preparation of latex concentrates. The creaming agents generally used are gums, pectins, gelatin, alginates and other similar hydrophilic colloids.

While working on the concentration of rubber latex the author has found that the seeds of *Adenanthera pavonina* (Coral Wood) provide a new source of creaming agent for rubber latex. Coral wood tree is found in the Himalayas, Western Ghats and Sylhet.

A convenient quantity of the powdered seeds was kept soaked in five to six times its weight of water for about four hours. The aqueous solution was decanted off, and the pasty mass mixed with seven to eight times its weight of water, and heated at 80° to 90° for about four hours. It was then filtered, and filtrate concentrated to about one-fourth of its original volume. Ninety-five per cent. alcohol was then added in such quantities that the final concentration of the alcohol did not go below 70 per cent. The flocculent precipitate that was formed was filtered, washed, dried and powdered. The yield of the material was about 5 to 6 per cent. based on the dry weight of the seeds. For concentration of rubber latex a 2 per cent. aqueous solution of the above powder was used.

To rubber latex of 30 per cent. D.R.C.. was added 0·2 per cent. (based on aqueous phase) of the creaming agent. After thorough mixing the rubber latex was kept undisturbed. Creaming started in about an hour, and was complete in about 12 to 14 hours. A cream of 58 to 60 per cent. D.R.C. separated at the top. The serum was found to contain less than 0·5 per cent. rubber.

This creaming agent gave the following reactions, usually characteristic of pectins:—

(1) Ten c.c. of a 1 per cent. aqueous solution of the creaming agent when mixed with 1 c.c. of a 10 per cent. solution of thorium nitrate set to a firm gel in about two minutes. This gel-formation was not observed in the presence of acetic acid.[3]

(2) Addition of calcium chloride solution to an aqueous solution of the creaming agent in presence of acetic acid resulted in the precipitation of calcium pectate.[4,5]

Further details will be published later.

The author's thanks are due to Sir Jnan Chandra Ghosh, KT., D.SC., F.N.I., for his keen interest in this work.

General Chemistry Lab.,
Indian Institute of Science,
Bangalore, GEORGE T. VERGHESE.
June 28, 1945.

1. Traube, *Brit. Pat.*, 1924, 226, 440. 2. —, *Gummi Ztg.*, 1925, **39**, 434, 1617. 3. Bryant, *Ind. Eng. Chem.* (Anl. Ed.), 1941, **13**, 103. 4. Carre and Hayne, *Biochem. J.*, 1922, **16**, 60. 5. Nanji and Norman, *Ibid.*, 1928, **22**, 596.

FERRIC TUNGSTATE GEL

In communications[1] from these laboratories the conditions of preparation of several ferric sols have been described. In this note the condition of formation of ferric tungstate gel has been investigated. Holmes[2] obtained gels of ferric phosphate and chromic arsenate. Ferric borate sols and gels were obtained by Prakash and Dhar.[3] Prakash[4] obtained a gel of ferric tungstate for the first time by mixing a 15 per cent. solution of sodium tungstate with M/2 ferric chloride solution.

I have observed that in presence of glucose ferric chloride dissolves a considerable amount of sodium tungstate to give a deep red positively charged sol of ferric tungstate. If this sol be purified by dialysis and then coagulated by electrolytes it sets to transparent jellies with slight opalescence.

To 50 c.c. of ferric chloride solution (corresponding to 69·84 gm. of Fe_2O_3 per litre) was added 10 c.c. of 20 per cent. glucose solution and 40 c.c. of 10 per cent. Na_2WO_4, $2H_2O$ was slowly run into this mixture. The mixture was vigorously shaken and was then allowed to dialyse for three days. The purified sol thus obtained had the empirical formula 2 Fe_2O_3. $Fe_2(WO_4)_3$ and set to jellies when coagulated with KCl or K_2SO_4.

The influence of the variation of the concentration of the coagulating electrolyte on the time of setting of the gel is shown in the following tables:—

TABLE I

Amount of sol taken = 3 c.c.; Total volume = 6 c.c.

Amount of $N/50K_2SO_4$(c.c.)	3	2·8	2·6	2·4	2
Time of setting (Minutes)	14	40	70	140	No jelly

TABLE II

Amount of sol taken = 2 c.c.; Total Volume = 4 c.c.

Amount of N/2 Kcl (c.c.)	2	1·9	1·8	1·7
Time of Setting (Minutes)	5	13	30	No jelly

It has been further observed that this sol itself sets to a transparent jelly when kept in a Jena bottle for about fifteen days.

The author expresses his deep gratitude to Dr. Satya Prakash for guidance during the progress of this work.

Chemical Research Laboratory,
Allahabad University, S. P. MUSHRAN.
June 15, 1945.

1. Prakash and Mushran, *Allahabad Univ. Studies*, 1943, **19**, 1; Mushran, *Curr. Sci.*, 1945, **14**, 123. 2. Holmes and Co-workers, *J. Amer. Chem. Soc.*, 1918, **40**, 1014. 3. Prakash and Dhar, *J. Ind. Chem. Soc.*, 1930, **7**, 367. 4. —, *Ibid.*, 1929, **6**, 587.

ISOLATION OF SOME TOXIC FACTORS FROM ARGEMONE OIL

Argemone oil has been held to be the factor responsible for causing epidemic dropsy in man by a number of investigators especially by Lal *et al.*[1] Sarkar[2] pointed out certain anomalies of the theory and stressed on the fact that a definite solution of the problem could

only be arrived at by isolating the active substances both from the argemone oil and the toxic mustard oil and then showing that they were chemically identical and that they also possessed similar physiological properties.

In their latest communication on the subject, Lal *et al.*[3] stated that the nitrogenous bases they had been able to separate, so far, were not toxic to man but might produce some histological changes in albino rats without any mortality however. They suggested that the substances they had been able to isolate formed part of an original complex toxic molecule. Their attempts to recombine the split products into this hypothetical toxic molecule did not materialise.

Attempts were made, therefore, to isolate compounds from argemone oil in various ways and to see if any of them were toxic. Accordingly, a number of compounds giving tests for alkaloids were obtained from this oil by (1) saponification method of Lal *et al.*,[4] (2) HCl gas extraction method of Lal *et al.*,[4] (3) ferric chloride method of Sarkar,[5] (4) extraction with cold dilute hydrochloric acid, 1 : 4, and (5) precipitating the nitrogenous bases as picrate.

By methods (3) and (4) hydrochlorides of base or bases were obtained directly. Compounds obtained by the other methods were converted into hydrochlorides with great difficulty.

The toxicity of these compounds were then tested by administering to young albino rats aqueous solution of various hydrochlorides orally in 1 mgm. daily doses. It was observed that hydrochlorides of compounds obtained by methods (1) and (2) were not much toxic but those obtained by methods (3) and (4) were definitely toxic having produced more than 50 per cent. mortality within 30 and 44 days respectively. The hydrochloride obtained from the picrate (method 5) appeared to be the most toxic since there was cent. per cent. mortality. It was even fairly toxic in 0·5 mgm. dose as there was 50 per cent. mortality within 22 days.

Further investigation showed that this picrate was a crude mixture from which so far two definite fractions could be isolated. One of them (Fraction I) is of light yellow colour and the other one (Fraction II) was of red colour.

Fraction I after several recrystallisations melted at 220-222° C. with decomposition. Toxicity determinations carried out with 1 mgm. daily dose of the hydrochloride as before showed that this fraction was much more toxic and two out of three rats died within a week. The post-mortem examination showed that there was punctate hæmorrhage in the liver with marked congestion, the heart was dilated and there was passive congestion in lungs and kidneys. There was also a marked bloating up of the intestine and stomach. The animals appeared to have developed a limpid gait before death showing paresis of hind legs. In addition there was a marked dyspnœa and the condition of rats was very low.

Fraction II after several recrystallisations melted at about 250° C. with decomposition. The hydrochloride from this picrate was also very toxic as there was cent. per cent. mortality within 23 days. The post-mortem examination showed that the liver was congested and there were hæmorrhagic patches here and there. The heart was dilated and in lungs hæmorrhage was noticeable. The kidney showed signs of passive congestion.

Argemone oil, therefore, contains at least two toxic compounds. It should be borne in mind, however, that mere isolation of two toxic substances does not necessarily imply that they are really the causative factors in epidemic dropsy and to settle this point satisfactorily other data would be necessary.

Further work is in progress and details will be published elsewhere in due course.

Our best thanks are due to Professors J. K. Chowdhury, F.N.I., and S. N. Bose, F.N.I., for their kind interest.

Biochemical Laboratory,
University of Dacca,
May 21, 1945.

S. N. SARKAR.
MD. BAZLUR RAHMAN.

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CUPRIC PENTAMMINO-SULPHATE.

THE deep blue liquid obtained by dissolving copper sulphate in a solution of ammonium hydroxide has been studied by numerous workers. C. Immerwahr[1] suggested that in the solution $Cu^{\cdot\cdot}$ ions are replaced by more complex cupric-amino ions. A. Reychler,[2] D. P. Konowaloff,[3] W. Gaus,[4] and J. Locke and J. Forsall,[5] by freezing point, absorption and vapour pressure measurements respectively found the compound formed to be $Cu(NH_3)_4$-SO_4. H. M. Dawson and J. Mc Crae,[6] D. W. Horn,[7] A. A. Blanchard,[8] P. Job,[9] S. Glasstone[10] and others have all found the same formula by various means. S. S. Bhatnagar, D. N. Goyle and M. Prasad,[11] however, ascribe the blue colour of the solution to colloidal copper hydroxide. In a recent communication[12] we have reported the existence of bi-, tetra-, penta- and hexa-amino compounds in the solution.

A blue amino compound was isolated by adding alcohol to the blue solution of ammoniacal copper sulphate. This compound was filtered, washed with alcohol and decomposed by adding a solution of caustic soda when black copper oxide precipitated out and was estimated. The ammonia evolved was absorbed in a standard sulphuric acid solution and was then estimated. As a result of the analysis the amounts of both copper and ammonia were known and the $Cu:NH_3$ ratio was found to be 1 : 5. The compound thus isolated, which was so far called to be the tetramino compound, was now found definitely to the cupric pentamino sulphate.

Detailed procedure and results of the method

will be described in a subsequent communication.

Chemical Laboratory,
The University,
Allahabad,
April 14, 1945.

ARUN K. DEY.
A. K. BHATTACHARYA.

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JUTE FABRIC-SHELLAC LAMINATES

I WAS most interested to read the extracts from an address delivered by Sir S. S. Bhatnagar at the Central India Centre of the Institute of Engineers (India), as given in the issue of *Current Science* for May 1945. That scientific achievements born of war necessity have been literally prodigious is no understatement and numerous examples have been given in Sir Shanti's address. There is little doubt also that many, if not most, of these achievements will be turned to good use for the benefit of the community in the post-war years. Much has been written of India's contribution to the war effort, but possibly much more still remains to be written as and when facts can be made known, although in all probability those most closely associated with new developments will remain true to tradition and prefer to remain anonymous.

Mention has been made in the address of unburstable containers and jettison tanks; also of fabric laminates for use in the fabrication of car bodies and made from jute or canvas cloth in combination with plastics. Since these are manufactures of which considerable practical and production experience already exists, I would like to take this opportunity, through your columns, of making reference to a jute fabric-shellac laminate which has been in full-scale production for nearly three years and has not only done service for the uses mentioned, but even greater service for many other uses of importance to the war effort. This fabric laminate is a 100 per cent. Indian indigenous product, is manufactured by a novel process, essentially simple in principle, and uses in its manufacture the natural resin shellac, or modifications thereof. Detailed production figures cannot be given for certain reasons but it can definitely be stated that the product has created during its relatively short existence a very large additional outlet for both jute fabric and shellac. A measure of publicity will be given in due course but a brief history of its development may be of interest.

The product to which I refer is termed "JUTLAC" and was developed at the express request of one of the large oil companies in India and also to assist the tea industry. In the case of the former to produce substitute grease containers in place of black sheet metal, and in the case of the latter, to provide a robust and reliable substitute for imported plywood. These approaches were made to the Research Institute of the Indian Jute Mills Association towards the end of 1941, when circumstances and conditions were approaching their very worst, and they were made as something of a last resort some considerable time after similar approaches had been made to official Research Institutes and Institutions in India. It was emphasised that more than samples must be produced that the raw materials required should be readily available in India, and that production had to be obtained in the shortest possible time. The obvious choice for raw materials were jute fabric and shellac, both of which were readily available, and in sufficient quantity. As a result, the I.J.M.A. Research Institute in its turn made an approach to a well-known Calcutta firm of shellac manufacturers who had been similarly approached to provide other substitutes by the Directorate-General, Munitions Production. By combining resources and technical skill it was possible not only to evolve a practical method of manufacture, which could be done on relatively simple plant, but such plant was constructed in the workshops of the firm concerned and subsequently in those of specially selected Calcutta jute mills. There was no question that when Calcutta eventually became a danger zone, production would have to be abandoned, and such was fully maintained throughout this somewhat difficult period.

The production of fabric laminates under normal conditions is well established practice and in the main consists of bonding resin-impregnated fabrics under heat and pressure in hydraulic presses. Such methods could not be put into practice in India to give even reasonable production, because, firstly, industrial presses of the type required were either not available, or only available in negligible numbers, and in any case the production of the latter would most probably have been taken up in other directions. Secondly, spirit solvents or other vehicles are generally used for dissolving the resin and the supply of sufficient industrial spirit, then on very short supply, was not available for release. Had spirit been available in sufficient quantity, solvent recovery units would have been required to make the process even reasonably economic, and finally, the capital cost of installation of hydraulic presses with all the accessory equipment required would have been enormous if the production required was to be obtained. Each and all of these difficulties which blocked large-scale production of fabric laminates, with circumstances as they were, do not exist in the processes for "Jutlac" manufacture and the resulting product is characterised by its toughness and flexibility.

Many millions of square feet of this product have been produced and it is fitting to record that the first machine was built and in pro-

duction early in 1942, only a matter of months after the original approaches to produce a black sheet metal and plywood substitute were made.

As regards the uses to which the product has been put, only a few need be mentioned as examples. Hundreds of thousands of grease drums have been made and many hundreds of thousands of tea-chests. Some three-quarters of a million "Jutlac" liners for supply-dropping equipment have been produced and hundreds of thousands of square feet supplied and used in the fabrication of military vehicles. As regards jettison petrol tanks for aircraft, several hundred were fabricated which passed all tests satisfactorily; these tanks were chiefly of 45 gallon capacity but also larger tanks of 90 gallon capacity were made. Plans were ready to expand production of these tanks but such did not have to come into operation because of a fortuitous change in the situation. "Jutlac" has been used by the British Military and Air Force Services and by the U.S.A.A.F.; it has been used by the tea industry, the oil industry and by other large industries. It has been used in building construction, for panelling, for racking and for boxes. It also makes serviceable suitcases. Moreover, it has been successfully used, and complaints from the users have been practically nil, perhaps a fitting tribute after three years' experience in usage for so many different purposes. As already stated the material is 100 per cent. an Indian indigenous product, evolved, developed and put into production during a very difficult period. A large-scale research and development plan is in course of projection, which will open out possibilities for the establishment of a new industry entirely indigenous to India.

Research Institute,
Indian Jute Mills Association,
Calcutta, W. G. MACMILLAN.
June 6, 1945.

DETERMINATION OF TOTAL SOLIDS IN MILK

DURING our experience of examination of milk for the prevention of adulteration under the Bombay Prevention of Adulteration Act, it has been found that the Total Solids of milk, when calculated by means of Richmond formula, is generally in excess than that determined by direct gravimetric method. Moreover, when the milk is adulterated either by abstraction of fat, watering, or both, this discrepancy between the two methods is found to be high (see table).

This is so, because the specific gravity of milk is raised by the abstraction of fat and lowered by the addition of water. Hence, by partial skimming and watering, an adulterated sample may possess the same specific gravity as that of genuine milk. In such a case, the Total Solids calculated by Richmond formula will be found higher than the actual present in milk, inasmuch as it will not take into account the adulteration of water, as the specific gravity will be that of genuine milk, even though abstraction of fat will be accounted for. For such cases, no formula, either for buffalo or cow milk will satisfactorily work,

Sample No.	Specific Gravity, at 60° F.	Fat %	Total Solids %, by Richmond formula	Total Solids %, by gravimetric method	Excess, by formula
1	1·027	3·4	10·9	8·6	2·3
2	1·023	2·8	9·2	7·0	2·2
3	1·033	3·8	12·9	9·9	3·0
4	1·025	3·0	10·0	8·2	1·8
5	1·023	2·6	9·0	5·8	3·2
6	1·023	2·8	9·2	7·3	1·9
7	1·036	6·8	16·3	15·0	1·3
8	1·037	5·4	15·9	12·6	3·3
9	1·029	4·8	13·1	10·6	2·5
10	1·033	5·6	15·1	12·2	2·9
11	1·034	5·1	14·7	10·9	3·8
12	1·029	4·4	12·6	10·0	2·6
13	1·026	4·2	11·6	9·1	2·5
14	1·042	6·0	17·8	14·2	3·6
15	1·042	6·8	18·8	15·2	3·6
16	1·027	2·3	9·6	8·1	1·5

because specific gravity of milk varies directly as abstraction of fat and inversely as addition of water. Whether, therefore, the specific gravity is normal or otherwise, it is necessary to determine the fat and total solids by gravimetric method.

In this Province Total Solids in milk are calculated on the Richmond formula, in some of the Public Health Laboratories, while in others, by the direct gravimetric method. In view of this, when milk samples under Bombay Prevention of Adulteration Act are sent for analysis from one part of the Province to another, the results are found to be different. Due to this, the accused is given benefit of doubt and acquitted. Hence uniformity of standards as well as methods of analysis and calculation should be laid down by the Central Advisory Board for Food Adulteration, Government of India, for milk and its products.

Public Health Laboratory,
Borough Municipality, C. M. DESAI.
Surat, A. H. PATEL.
June 26, 1945.

TAMARIND SEED "PECTIN"

NANJI *et al.*[1] pointed out in a recent issue of this *Journal* that the "pectin" prepared from tamarind seed according to the method of Krishna and Ghose[2] is "not a pectin as ordinarily understood" as it fails to give some of the characteristic pectin reactions and as it contains nitrogenous material. We had occasion to deal with this substance in the course of a systematic investigation on pectins from Indian plant materials completed in this laboratory some time ago and, after examining it in some detail, reached the conclusion that it was not a pectin. The investigation was undertaken mainly with the object of discovering a source of galacturonic acid required for the

technical synthesis of vitamin C. Tamarind seed was the first raw material to be examined as it was stated to contain 60 per cent. of pectin and was available in quantity. But the substance prepared according to the directions given by Krishna and Ghose[2] failed to yield on acid hydrolysis any appreciable quantity of galacturonic acid. When analysed for the calcium pectate number by the quantitative method of Carreè and Haynes,[3] tamarind seed meal gave a zero value indicating the absence of pectin. For further study the material prepared as above was hydrolysed with acid. Hydrolysis with 3 per cent. sulphuric acid for eight hours gave the maximum yield of reducing sugar, *viz.*, 83 per cent. of the weight of substance taken. In this hydrolysate the only sugars that could be identified were *l*-arabinose and *d*-glucose. The following quantitative estimations were carried out on the preparation: methoxyl (micro-Zeisel), uronic acid by determination of the carbondioxide evolved on decarboxylation (Dickson, Otterson and Link),[4] pentose from the amount of furfuraldehyde formed on hydrolysis with 12 per cent. hydrochloric acid (Doree).[5] From these analyses the substance was found to contain methoxyl 1·08 per cent., uronic acid residues 12·59 per cent., araban 33·22 per cent., glucosan 53·11 per cent. Krober's[5] tables were used for calculating the pentosan content; the correction for the furfuraldehyde derived from uronic acid was based upon Norris and Resch.[6]

It is obvious from these results that the substance is not a pectin although it shares with pectin the useful physical property of forming sugar-acid-jellies. Pectin is now known to be a macro-molecule consisting essentially of a chain of galacturonic acid residues in glucosidic union with each other, some of the galacturonic acid units being in the form of the methyl ester (*cf.* Morrell, Bauer and Link;[7] Schneider *et. al.*[8,9,10]). There is at present insufficient evidence to conclude whether the arabinose and galactose usually obtained from pectin preparations are in true chemical combination with the galacturonic acid or only arise from associated galactants and arabans which are not removed in the course of preparation. For the uronic acid content, values as high as 96%[9] has been claimed for specially purified pectins. Ordinary commercial preparations usually contain about 68%[11] uronic acid. The corresponding methoxyl values are 11·6%[9] and 6%[11] respectively.

The low methoxyl and uronic acid content of the tamarind seed preparation as well as the nature of the sugars derived from it preclude the possibility of it being classed with the pectins. It has greater similarity in chemical composition to the mucilages isolated from certain seeds (*cf.* mucilages from Psyllium,[12] rib grass seed,[13] Indian wheat[14]) which contain in general pentose and hexose sugars in combination with only a small proportion of uronic acid.

M. Damodaran.
P. N. Rangachari.
University Biochemical Laboratory,
Madras,
July 12, 1945.

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PROCESSING OF SOYA-BEAN FOR THE PRODUCTION OF MILK

During recent years, milk shortage in India has assumed alarming proportions. Attention of the public to this important point has been focussed by the daily press. *Indian Farming*[1] has published some important statistical information regarding the extent of shortage. The annual production of milk in India is estimated to be 800,000,000 maunds; but the *per capita* consumption of milk is only 7 ozs. per day compared to 35 ozs. in U.S.A. The minimum requirement of milk for a growing child is 32 ozs. and 16 ozs. for an adult; so, the supply of milk should be increased to at least three times the present production. This production cannot be achieved for several years to come; so, our attention was directed to the possible utilisation of soya-bean to make up the deficit in our milk supply.

The soya-bean milk has been extensively used throughout the Orient since its discovery by the Chinese philosopher, Wahi Nain Tzelang, some time before the Christian era. In China the soya-milk is being prepared and used in every household as a daily routine. The soya-bean milk is usually prepared by first soaking the beans for a few hours in water. They are then crushed into a fine texture mash. This is boiled for some thirty minutes in the proportion of three parts water to one of mash. The 'milk' is then filtered through cloth. The 'milk' thus obtained is not very palatable and is slightly coloured. Prepared in the above manner, the nutritive value is also not high. In view of these, we concentrated our attention on the improvement of processing and have been able to prepare a 'milk' which has an agreeable taste and has, at the same time, a good nutritive value.

The nutritive value of soya-bean milk has already been the subject of some study. Tso[2] fed infants successfully with soya-bean milk prepared in the ordinary way and found that in 8 months an average child grew 20·7 cm. and gained 4·1 kg. in weigh, a growth record which compares favourably with the average development of breastfed infants. Rittinger and Dembo[3] fed fifty infants for a period of one year with addition of sugar and various salts and they concluded that soya-milk can be made into an adequate food for infants. Recently, Cahill *et al.*[4] studied the biological value of soya-milk prepared by Borden & Co,

on human subjects and found that the biological value of the 'milk' is 95 when egg protein is taken as the standard. The method of manufacture is not given.

That the nutritive value of raw soya-bean is not good has been shown by the researches of Osborne and Mendel[5]. They found that raw soya-bean when fed to rats as the sole source of protein in an otherwise complete ration did not support appreciable growth. However, normal growth resulted when they fed soya-beans which had been previously cooked. Hayward *et al.*[6] have shown that the expeller process soya-bean meal contains proteins which have twice the nutritive value of raw soya-beans. Everson *et al.*[7] from growth-studies on young rats have found that germination increases the biological value of the protein to more than triple the original value. Germination not only increases the nutritive value of the protein, but the vitamin content is also greatly increased.[8] The riboflavin and nicotinic acid content are increased to more than double the original value.

In view of the foregoing observations, we tried to prepare soya-milk from the germinated bean. Another advantage of the germination is that it makes the beans more palatable. The procedure employed by us for the production of milk is as follows:—

Take 1 lb. of soya-bean and soak it in sufficient water for 5 hours, then put it in bags and suspend in an open place for 48 hours. The bags are soaked thrice daily in water to keep the seeds moist. By this time, the seedlings attain an average length of ½ cm. The seeds are then freed from the adhering skin by rubbing with hand. The next procedure is the removal of the bitter principle and the colouring matter and this is largely effected by heating the seeds at 70° C. for 30 minutes with four times its weight of water. Addition of 0·2 per cent. sodium bicarbonate or 1 per cent. glycerine to the extracting water improves the efficiency of extraction. The water extracting the colouring matter and the bitter principle is thrown away and the beans are washed thoroughly with hot water. The clean kernel is then made into a fine paste. This can be done in any suitable wet grinding machine if the 'milk' is to be prepared on a large scale. The pasty mass is then boiled with four times its weight of water for half an hour. The 'milk' is strained through cloth. Two per cent. sugar and 0·5 per cent. calcium lactate or gluconate may be added to improve the taste and calcium content. The average composition of the 'milk' thus obtained is as follows:—

Total solids—10·1 per cent.
Protein—4·2 per cent.
Fat—3·4 per cent.
Carbohydrates—1·8 per cent.
Salts—0·7 per cent.

The keeping quality of soya-milk is better than that of ordinary milk and the 'milk' is fairly stable. The growth response of young rats fed on soya-milk is 90 per cent. of that obtained with pure cow's milk. The digestibility and the biological value of the proteins of the 'milk' have been found to be 90 and 81 respectively. The vitamin content of soya-milk as prepared by the above method as compared with that of cow's milk (average of six samples) is as follows:—

Vitamin contents per litre of milk

	Soya milk	Cow's milk
Vitamin A (as carotene) ..	750 I.U.	1050 I.U.
Thiamine	0·82 mg.	0·43 mg.
Riboflavin	1·10 mg.	1·32 mg.
Nicotinic acid	2·49 mg.	1·16 mg.
Ascorbic acid	21·60 mg.	17·84 mg.

From the above results, it will be seen that soya-milk as obtained by the improved method is nearly as good as and in some respects, even superior to good cow's milk. Further investigations bearing on the nutritive value of the 'milk' are in progress.

S. S. De.
V. Subrahmanyan.
Department of Bio-Chemistry,
Indian Institute of Science,
Bangalore,
July 19, 1945.

1. *Indian Farming*, January, 1945, **4**. 2. Tso, *Chinese. J. Physiol.*, 1928, **2**, 33. 3. Rittinger and Dembo, *Am. J. Diseases Children*, 1932, **44**, 1221. 4. Cahill, Lawrence, Schrœder and Smith, *J. Nutrition*, 1944, **28**, 209. 5. Osborne and Mendel, *J. Biol. Chem.*, 1917, **32**, 369. 6. Hayward, Steenbock and Bohstedt, *J. Nutrition*, 1936 **11**, 219. 7. Everson, Steenbock and Ceder-quist, *Ibid.*, 1944, **27**, 225. 8. French, Berryman, Goorly, Harper, Harkness and Thacker, *Ibid.*, 1944, **28**, 63.

A POSSIBLE USE OF SILKWORM BODY POWDER

Mr. M. J. Narasimhan, Director of Agriculture, Mysore State, kindly supplied a dried powder of apparently uniform quality, obtained after drying the dead bodies of silkworms which are thrown away after the silk is obtained. These silkworm bodies and associated material are at present stacked as refuse, round the villages, where silkworm rearing is a cottage industry or from silk-throwing factories after obtaining the silk, for possible use as manure. An evil smell is produced during the decomposition of this refuse. The powder obtained by drying the silkworm body and grinding, is light brown in colour, fluffy, slightly sticky to the fingers and has a strong characteristic odour not unlike dried meat-powder.

One pound of the powder was extracted with a litre of water at 80° C.; the extract was found to contain about 1·21 grams of total solids per 100 ml.; the broth emulsion so prepared was used, instead of the usual beef-broth, for preparing solid Agar media. No peptone was added. 2·5 per cent. of Agar was used for preparation of Agar slopes and

stands (useful for pour plates); they were transluscent, but deep brown in colour, in spite of using egg-white as a clearing agent. The typhoid bacillus (Rawling's strain), the para-typhoid A & B and vibrio cholera grew rapidly and well on this media ($45 \pm 4\cdot5$ millions per square centimetre of surface by 1 ml. of water after 24 hours, at 37° C.); one obtained about the same quantity of growths as becomes available on ordinary Agar slopes prepared with beef-broth, peptone and 2 per cent. Agar, *i.e.*, the routine Agar media used in this Laboratory. Preservation at ice-box temperature (6°C.) for over a week, dries the media so that only a few discrete colonies grow after 24 hours incubation at 37°C.; splitting of the Agar and drying at the tip of the slant occurs. Ordinary Agar media as prepared in this laboratory can, however, be used after 12 days to a fortnight, just as fresh Agar.

Experiments are also in progress for the preparation of peptone (not easily available in the Indian market now—Witte's peptone is not available, and Difco peptone sells at Rs. 65 per lb.) by the use of papain. Preliminary tests are promising.

It is hoped soon to present a more comprehensive study of the use of silkworm powder for bacteriological purposes.

Public Health Institute,
Bangalore, C. V. NATARAJAN.
May 12, 1945.

POPLITEAL FACET IN SQUATTERS

SOME interest has centred round the variations in the lower end of a femur occasioned by the squatting posture,[1-4] and the present communication is to record yet another variation in the lower end of femora from Punjabis of lower classes, who adopt the squatting posture not only during work but also during rest. In a series of two hundred femora examined, a curved facet, covered with cartilage, was detected in all of them in the posterior part of the lateral aspect of the lateral condyle. It was well marked in some, less so in others, but was present in all. This facet may be looked upon as an extension of the femoral condylar articular cartilage on the lateral aspect posteriorly, just as quadriceps facet[1] is an extension of cartilage anteriorly.

The popliteal muscle arising from the anterior end of the popliteal groove on the lateral side of the lateral femoral condyle, and getting insertion on the upper end of the posterior surface of the tibia, lies in the popliteal groove in the flexion of the knee joint but moves in an arc on the lateral side of the lateral femoral condyl during the movement of extension, till the tendon lies obliquely from before backwards, bevelling the anterior part of its lower border. The friction between the tendon and the side of the condyle is obviated by the synovial membrane acting as a bursa.

As the movements of the knee joint are more frequent in squatting than non-squatting races,[1] popliteal tendon rubs against the lateral condyle much more frequently in the former than in the latter. The popliteal facet owes its existence to this fact.

Department of Anatomy,
Dow Medical College,
Hyderabad (Sind), M. A. SHAH.
May 24, 1945.

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ON THE DEVELOPMENT OF THE FEMALE GAMETOPHYTE IN *HYDROLEA ZEYLANICA* VAHL.

THE single Indian genus, *Hydrolea*, of the Hydrophyllaceæ, is represented by a single species, *Zeylanica*, throughout India abundantly in wet places and rice swamps according to Hooker.[1] The ovule is anatropous and has a single integument. The female archesporium is hypodermal in origin and is usually a single cell but two such cells are noticed side by side oftentimes. It directly functions as a megaspore mother-cell. As a result of the reduction divisions a normal linear tetrad of four megaspores is produced. Only the chalazal megaspore is functional, while the upper three degenerate. The mature embryo-sac is eight-nucleate and normal. The antipodals lie as nuclei and persist till fertilization. Polar fusion takes place before fertilization of the egg but their nucleoli remain separate and distinct for some time in the secondary nucleus. The synergids are comparatively larger in size and they possess big vacuoles at their upper and lower ends. The apices are rounded and not pointed and pyriform as observed by Svensson[2] in *Nemophila* and *Phacelia* of the same family. The egg is much smaller in size and lies at the lower level in the much vacuolated cytoplasm of the sac.

Since the formation of the linear tetrad, the nucellar tissue surrounding it begins to degenerate and they lie as disintegrated cells on all sides and persist till the maturity of the embryo-sac. The cells of the jacket layer which is organised by the innermost layer of the integument, enlarge before the tetrad division of the embryo-sac mother-cell; at the apex near the integument they become rich in cytoplasm and elongated in the radial direction. As soon as the cells of the nucellus are disorganised and absorbed, the fully formed embryo-sac is clearly outlined by this jacket layer.

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Dacca, J. N. MITRA.
February 15, 1945.

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THE NATURE OF THE INFERIOR OVARY IN AMARYLLIDACEAE

THE study of transections of flower buds of *Eucharis amazonica* (family *Amaryllidaceæ*) shows that the pedicel possess as a rule an undulating ring of twelve collateral vascular bundles. Six of these are somewhat bigger in size than the alternating six. Of the first six, three again are larger than the alternating three. At the very base of the inferior ovary, the three largest bundles, which are on the same radii as the outer whorl of perianth leaves, divide to form the midrib bundle of an outer tepal, the trace of the superposed stamen and the midrib bundle of one of the carpels on the same radius. The three alternating large bundles, which are on the same radii as the inner whorl of perianth leaves, divide to give rise to the midrib bundle of one of the perianth leaves and the trace of the superposed stamen. The division of the bundles takes place in the same manner as Arber[1] has described in *Hymenocallis*, *Narcissus*, etc. The six smaller bundles of the pedicel divide to form the marginal traces of the adjacent perianth leaves. Thus a transection of the ovary about the middle shows the vascular supply of all the floral whorls quite distinctly marked off from one another even in the wall of the ovary. And, just as Joshi and Pantulu[2] have shown in *Polianthes tuberosa* belonging to the closely related family, Agavaceæ, it is very clear that in *Eucharis amazonica* also the inferior ovary and epigyny have originated as a result of the adnation of the perianth leaves, stamens and carpels.

The author takes this opportunity to express his gratitude to Dr. A. C. Joshi for suggesting the problem and guidance during the progress of the work.

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March 15, 1945. S. B. CHATURVEDI.

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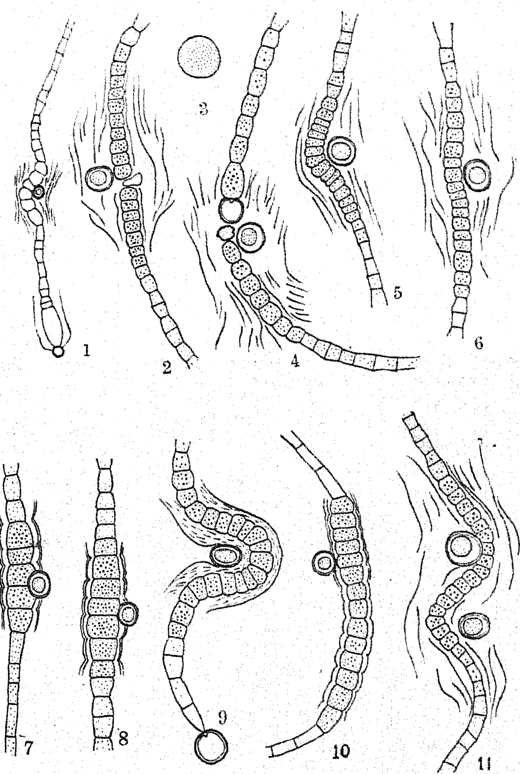
NOTE ON THE REACTIONS OF *GLOEOTRICHIA RACIBORSKII* WOLOSZ., TO A PARASITIC ATTACK

WHILE examining some preserved material of *Glœotrichia Raciborskii* Wolosz., collected from a lake at Chingleput, the writer came across filaments which were bent in various ways in the middle. A tiny, round, unicellular fungal (?) parasite was found attached to the filament laterally on the inner side of the bent portion (Fig. 1). At first sight this tiny parasite looked like a lateral heterocyst on the filament or a heterocyst of the alga lying loose at the side of the filament, since it showed a certain amount of resemblance to the heterocyst of the alga both in shape and size. A careful examination of the cell, however, showed that it was not a part of the alga, but some foreign organism attached to it. Its contents were more or less homogeneous and colourless and its wall was thin, firm and very finely punctate (Fig. 3). This parasite could not be identified as no other stage of its life-history could be seen in the material.

The chief interest lies in the reaction of the algal filament to the fungal attack. At the region of attachment of the parasite, the cells



FIGS. 1–11. *Glœotrichia Raciborskii* Wolosz.

Fig. 1. A filament showing the parasite inside the characteristic bend. Fig. 2. A portion of the filament, the cell attacked by the parasite dead and degenerating. Fig. 3. The parasite showing the punctate wall (cell contents not shown). Fig. 4. A portion of the filament with the adjoining cell above the dead cell converted into a heterocyst. Fig. 5. A portion of the filament bent round the parasite. Fig. 6. A portion of the filament just beginning to bend round the parasite.

Figs. 7 and 8. Portions of filaments showing larger and bigger cells with rich contents. Fig. 9. A portion of the filament showing the characteristic bend with the parasite well enclosed in the bend. Fig. 10. A portion of the filament with a number of cells becoming larger. Fig. 11. A portion of the filament with two parasites and two bends.

(Figs. 1–6, 11 from Chingleput lake material and Figs. 7–10 from Elliot's Beach pool material. Fig. 1 × 190, Figs. 2, 4–11 × 333·3 and Fig. 3 × 500).

of the filament increased in contents and became meristematic and soon began to divide repeatedly (Fig. 6). At the same time a dense mucilage was secreted round the filament at this region, and this mucilage later on became brown and lamellated. As a result of this increased growth the algal filament becomes more or less bent round the parasite (Figs. 5, 11). No haustorial connection of any kind between the parasite and the host filament could be made out in the formalin material, but it is reasonable to presume that some kind of haustorial connection probably of a very delicate nature existed in nature and was not preserved in formalin material. The particular cell to which the parasite is attached often degenerates and dies (Fig. 2) and the adjoining cell on the upper side of the filament then becomes converted into a heterocyst (Fig. 4). And the cell next to this heterocyst occasionally develops into a spore. In other words, after the death of the cell attacked by the parasite, the portion of the algal filament above the dead cell behaves like a new filament of *Glœotrichia Raciborskii* with a basal heterocyst of its own.

This parasite was found later on in another collection of *Glœotrichia Raciborskii* from a fresh-water pool near Madras. The alga showed the same reactions to the attack of the parasite (Fig. 7-10).

Instances of *Glœotrichia* being attacked by a parasite do not appear to have been recorded previously. No case of any fungus-attacking *Glœtrichia* is given by Lemmermann (1910), Oudemans (1919) and Seymour (1929).

The author wishes to express his indebtedness to Prof. M. O. P. Iyengar for his kind help and guidance during this investigation.

University Botany Lab.,
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May 1, 1945.

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A MOSAIC DISEASE OF CARDAMOM

MOSAIC of cardamom, *Elettaria cardamomum* Maton, also known by the name of *"katte"* or marble disease, is a serious affection of this crop and extends over a wide area. It occurs in Travancore, Mysore and North Kanara, in which latter area it is not only the commonest disease but causes most severe damage to the plants, rendering them commercially useless in a few years after planting.

The first visible symptoms of the disease are manifested by general chlorosis of the entire leaf with slender interrupted stripes of deep-green tissues over its surface. These stripes follow along the veins and run parallel to each other from the mid-rib to the margin of the leaf. When the disease is fully developed, the stripes of green tissue are almost evenly distributed over the leaf, presenting a characteristic mosaic pattern. In nature, cardamom plants are susceptible to infection at all stages of growth.

Affected clumps deteriorate rapidly. The newly formed shoots from such clumps are reduced in size, and there is a gradual reduction in their productivity, followed by death. Many of the clumps wither before they begin to yield.

The disease was first reported by Mollison[1] who considered it a degeneration disease brought about by continuous culture of cardamom under the same conditions of soil and climate, and without any change in methods of propagation and reproduction. Later, Sahasrabuddhe and Bapat,[2] as a result of an investigation into the soils in the cardamom gardens in North Kanara, came to the conclusion that the *katte* disease was induced by an unfavourable soil condition associated with the prevalence of certain types of soil protozoa. Mayne[3] expressed the opinion that the disease was probably of virus origin.

The present experiments on transmission of the *katte* disease were done in insect-proof glasshouses at Sirsi in North Kanara. In some experiments 'sick' soil from diseased gardens or soil into which pieces of rhizomes and roots of affected plants were incorporated, was used to fill pots in which healthy seedlings were transplanted. In another experiment seedlings were directly planted in the garden in pits dug up to remove dead clumps and were carefully protected with muslin cages. In all cases plants under test remained healthy, showing that the disease is not soil-borne.

All attempts to transmit the disease by sap inoculation have so far been unsuccessful.

A survey of the insect fauna of the spice gardens in North Kanara revealed a species of thrips, *Tœniothrips cardamomi* Ayyer, two species of jassids, two species of white flies, and an aphid, probably *Pentalonia nigronervosa* Coq., commonly feeding upon cardamom plants. The aphids breed on the stems underneath loose leaf-sheaths, and large colonies of these insects are found on decaying cardamom plants. The aphids were also found breeding on banana plants.

In transmission experiments with the above insects, only the aphid, *Pentalonia nigronervosa*, readily transmitted the virus of cardamom mosaic. The disease developed in 21 to 46 days after the infective aphids were transferred to healthy plants grown in insect-proof glass-houses.

The above evidence shows that mosaic of cardamom is caused by virus and that it can be transmitted by *P. nigronervosa*, the insect vector of bunchy top disease of bananas. Experiments on transmission of the disease by sap inoculation and by seed are in progress.

Grateful acknowledgment is made of the facilities provided by Mr. Venkatrao V. Nilekani for carrying out experiments in his garden at Sirsi. This work is being carried out under the Plant Virus Research Scheme

financed by the Imperial Council of Agricultural Research.

College of Agriculture, Poona,
April 23, 1945.

B. N. UPPAL.
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THE MOTH *TARAGAMA SIVA* LEFROY, AS A PEST OF GUAVA TREE (*PSIDIUM GUAVA*)

THE caterpillar of *Taragama siva* Lef. (Lasiocampidæ, Lepidoptera) is recorded as a common pest of babul tree (*Acacia arabica*). Lefroy (1909) reports it also to be a pest of rose (*Rosa* sp.) and ber (*Zizyphus jujuba*). The writer finds it to be a pest of the guava tree (*Psidium guava*) at Calcutta.

A small number of caterpillars of this species were noted by the writer at the beginning of July 1944 on a young guava tree of about 9 feet in height. At the end of July 1944 the pests disappeared. In January 1945 the larvæ appeared again on the same tree and persisted till the end of February; as the branches of the tree later were cut down, subsequent history could not be traced. They were leaf-eaters and caused defoliation.

The maximum length of the larvæ was found to be 8·4 cm. The cocoons resembled the colour of the bark of the tree and were usually found in the hollows of the stems or near the axils of the branches. The cocoons were tough like packing paper, and were of 4·6 to 5·0 cm. in length. The duration of the pupal period varied from 12 to 20 days.

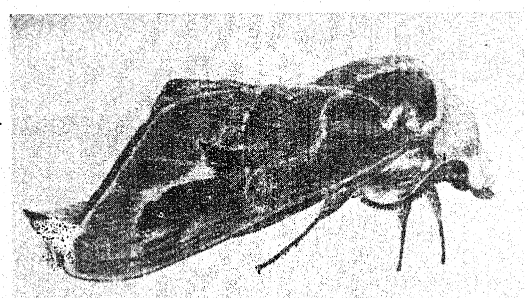

FIG. 1.—The moth *Taragama siva* Lefroy.

It is interesting to mention that by the side of the guava tree there were several rose plants, which are said to be infected.

It is also worth noticing that the petal infected the same tree twice consecutively, once in July (summer) and later in January (winter). But the writer did not find the pest on other guava trees of different gardens. It will be interesting to know whether *Taragama siva* Lef. occurs as a pest of guava trees of other localities, and this will determine the question whether its infection is sporadic or not.

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PRABHASKUMAR MITRA.

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A NOTE ON THE PREDATORY HABIT OF *TRIBOLIUM* BEETLES

TRIBOLIUM beetles are observed attacking different cereals, flour and, in general, all stored food products. It is almost a terrible pest attacking the food which is meant for human consumption, and, often the damage is even more serious than that caused by the weevils and other lepidopterus pests. During the course of breeding *Corcyra cephalonica* St. for the mass production of *Trichogramma minutum* at Walchandanagar, it was noticed that the eggs of the moth when inoculated in the culture, did not hatch properly and thus interfered with the multiplication of the moths.

Since these beetles are often found in large numbers in broken *Jowar* which is kept in cages for breeding the moths, their presence is usually ignored. However, their association under the circumstances when hatching was much reduced, created much suspicion and observations under controlled conditions were made. Critical observations on their activities have revealed that these minute beetles are a very serious problem in the culture of *Corcyra cephalonica* and the following observations are recorded in this connection.

Eggs of *Corcyra cephalonica* were introduced in jars in which broken *Jowar* was kept as food. In each of the three experimental jars beetles were also introduced. Every day fresh eggs were counted, mounted on cards and introduced into the jars. Observations were made after 24, 48 and 72 hours when the eggs in the jars were counted. In another jar broken *Jowar* free from *Tribolium* beetles was kept and a definite number of eggs were introduced as a control. The beetles in the jars fed voraciously on the eggs so much so, that only a negligible percentage of eggs were allowed to hatch. During the course of 11 days when the experiments were conducted (Table I) 4,050 eggs were introduced out of which 3,779 eggs, *i.e.*, 93·4 per cent., were eaten up by 84 beetles in the first 24 hours and ultimately only 105 eggs, *i.e.*, 2·4 per cent., were left for hatching. Therefore, enormous damage is caused to eggs which are introduced for the culture in the *Corcyra* breeding cages infested with *Trobilium* beetles. In the

TABLE I

Feeding of *Tribonium* beetles on the eggs of *Corcyra cephalonica* under captivity

Observations	No. of eggs introduced	No. of eggs fed upon			Unfertilised eggs	No. of eggs hatched
		24 Hrs.	48 Hrs.	72 Hrs.		
1	203	179	6	3	12	3
2	305	298	—	—	7	—
3	350	324	19	—	2	5
4	258	239	9	—	1	9
5	480	454	15	—	6	5
6	513	508	4	—	1	—
7	493	418	20	—	3	48
8	510	498	—	—	3	9
9	410	392	—	4	3	15
10	333	318	—	—	4	11
11	195	151	42	—	2	—
Control 185	*No. of eggs unfertilised* 4			*No. of eggs hatched* 181		

control, however, practically all the eggs hatched normally.

CONTROL

Sun-drying or sterilizing the food material at 60° C., are commonly recommended. These precautionary measures hold good only for the infestation already present in the food material. Our observations have revealed that these beetles are not harmful to the larvæ of *Corcyra cephalonica*. Hence it is recommended that besides sun-drying or sterilization, only the larvæ of *Corcyra cephalonica* St. should be introduced into the culture and not the eggs. This will immediately render the beetles harmless even if present in the breeding cages.

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April 13, 1945.

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A SPECIAL TECHNIQUE FOR THE IDENTIFICATION OF THE MEMBRACIDAE SPECIES BY THE INTRACELLULAR MICRO-ORGANISMS OF THEIR TUMOURS

SYMBIOTIC micro-organisms of many insects have been studied chiefly by European workers. As *Membracidæ* are rare in Europe, these have not been investigated thoroughly. It is proposed to present in this note the results of a few common species, with regard to the intra-cellular microorganisms found in the tumours.

The tumours are present in the abdomen of all the individuals at the two sides in the fatty-tissue of the insect. They are trilobed and can be separated very easily from the fatty-tissue under a binocular microscope. They look like glands, but naturally no ducts or outlets are present. In many cases they are pigmented—in *Oxyraches tarandus* Fabr., they are light pink, in *Leptocentrus lucaspis* Walk., yellow, in *Telingana caneacens* Buckt., pale yellow. If a smear of the tumour is made on a clean slide and stained according to the method given below, the micro-organisms are seen clearly within the cell and scattered outside also.

Smear of the tumour is made on a slide and while still moist the slide is flooded with Bouin's fluid. After treatment for 40 minutes with the fixative the slide is washed with 50 per cent. and 70 per cent. alcohols and later rinsed well in tap-water. It is then stained with Giemsa solution prepared by adding 1 c.c. of the stock solution to every 25 c.c. of the buffer, and stained for an hour. It is then washed with tap-water and subsequently treated for a few minutes with buffer and dried. When well-stained the smear presents a beautiful polychrome effect: the nuclei and microorganisms are of varying shades of pink and red, the ground cytoplasm blue and other cytoplasmic inclusions of mixed hues.

In Hyderabad proper there are about seven to eight species of the family Membracidæ which are easily available. They are found on *Acacia arabica* (Bhabul), *Psidium guava* (Guava tree), and *Zizyphus jujuba* (ber plant), and many other plants of economic importance. Some of the species like *Oxyraches tarandus* Fabr., *Otinotus oneratus* Walk., at the very sight give an impression that they are different species. But there are many other species which look alike, *e.g.*, *Tricentrus assamensis*, and *Tricentrus selenus* Buckt. In the nymphal stages it is still more difficult to differentiate one nymph from the other, although some do show a difference. But when the intra-cellular micro-organisms of the different species of *Membracidæ* are examined we get to the following picture. In *Oxyraches tarandus* Fabr., the micro-organisms are short and rod-like in form, and are found within the cell. Small granule-like bodies are also present in large numbers, and some of the granules assume beaded form as shown in Fig. 1. In *Leptocentrus lucaspis* Walk., the

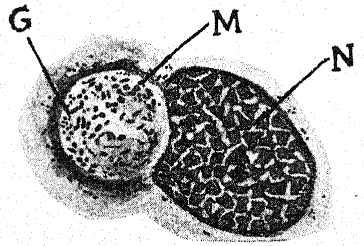

FIG. 1. *Oxyraches tarandus* Fabr.

micro-organisms are arranged in a circular manner within the cell in large numbers. The micro-organisms are more or less dumb-bell-shaped and they are generally present in pairs as shown in Fig. 2. In *Tricentrus assamensis* the micro-organisms are of very peculiar shape. They are long, threadlike and very often the threads are broken into small pieces as shown in Fig. 3. In *Leptocentrus longi-*

spinus Walk., the micro-organisms are spherical in form and look like yeasts. These are found in batches and also singly as shown in Fig. 4.

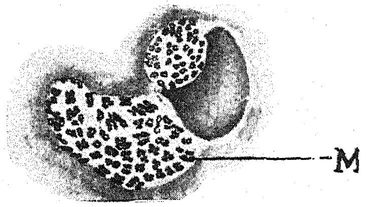

FIG. 2. *Leptocentrus lucaspis* Walk.

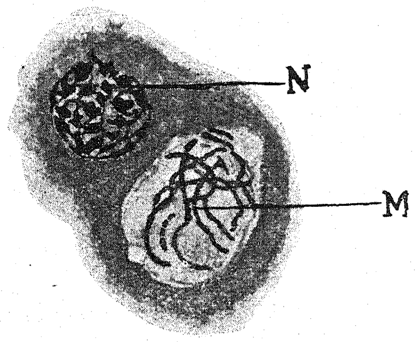

FIG. 3. *Tricentrus assamensis*

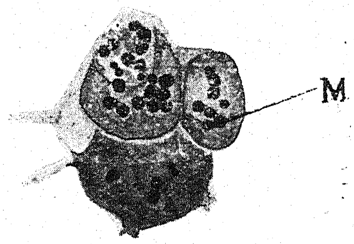

FIG. 4. *Leptocentrus longispinus* Walk.
(Magnified to 1000)
G—Granules. M—Micro-organism. N—Nucleus.

In some species like *Telingana canescens* Buckt., and *Tricentrus selenus* Buckt., the micro-organisms are not to be seen in the tumours when a smear is made and stained with Giemsa's stain. The above-mentioned variation is still under investigation and has to be confirmed.

In conclusion, it may be said that the examination of symbiotic micro-organisms whenever present greatly helps the identification of the species.

I am much thankful to Dr. S. Mahdihassan for his suggestions and active interest, and to Dr. B. K. Das, Chairman, Zoology Department, Osmania University, for his kind encouragement.

Hyderabad, MOHAN BABU NAIDU.
May 31, 1945.

A PRELIMINARY NOTE ON THE PLANKTON OF BOMBAY HARBOUR

THE plankton from Bombay and adjoining waters has not been regularly studied in the past and no published account of its composition, seasonal abundance and variation is available, except for a few notes on the systematics of such groups as Hydromedusæ[1] and Sagittæ[2]. We have, therefore, undertaken a systematic study of our local plankton with a view to collect such information as will, when accumulated, be of great practical help in the expansion of our fisheries on scientific lines. The present note is a result of our observations made during the past few years, particularly from June 1944. Plankton collections are made twice a week. Two hauls, each of fifteen minutes' duration, are taken each time. Moreover, a weekly record of chemical analysis of sea-water collected from the same site, together with the meteorological data is maintained to enable us to correlate at a later date the fluctuations in the planktonic population with the physical and chemical conditions of the sea.

The salient features of our plankton are the following:—

(1) The Hydromedusæ, Siphonophores, Ctenophores, Sagittæ and Copepods are some of the commonest members of our plankton obtained almost all the year round. The siphonophores and ctenophores are found in large numbers from November to March. The copepods have two periods of maxima, one in July and the other in January.

(2) Most of the Decapod larvæ make their appearance towards the end of rainy season and are found in majority of the subsequent catches till the end of March.

(3) The Tunicates appear by the middle of October and reach their maximum in January and February.

(4) The number of fish-eggs in our samples is lesser than those collected in European waters over the same period. Fish-larvæ and post-larvæ of some fishes occur over a number of months, thereby indicating a prolonged breeding season.

(5) The Diatoms and the Dinoflagellates which constitute the bulk of the phytoplankton are found in abundance during the cold months of the year, particularly January and February.

The following is the summary of the occurrence and seasonal variations of some of the important groups of planktonic organisms.

Protozoa (Infusorians, Dinoflagellates, Foraminifera and Heliozoa):—

Members of each of these groups occur in our collection almost throughout the year.

Cœlenterates:

Hydromedusæ form one of the major groups which, in our collection, include both littoral and oceanic forms carried in by the currents of water. Some of the commonest species are *Steenstrupia bigelowi*

(Mass.), *Phortis ceylonensis* (Browne), *Phialucium virens* (Bigelow), *Agiaura hemstoma* (Perorn et Lesueur), *Lirope tetraphylla* (Chamissao et Eysenhardt) and *Solmundella bitentaculata* (Quoy et Gaimard).

Siphonophores: These include species of Monophyes and Diphyes and a few colonies of Physonecti, the latter occurring in August, September, January and February.

Ctenophores: They consist of Pleurobranchia and Berœ, occurring in fairly large numbers from September to the end of March. The largest specimen of Berœ found in our samples was 2″ × 1″.

Polychœta:

Planktonic forms of Nereida occur at intervals all the year round but are very common from September to May. Tomopteris is fairly constant in our catch from September to March.

Chœtognatha:

The three commonest species of Sagittæ are *S. gardineri* (Doncaster), *S. bedoti* (Beraneck), *S. Bombayensis* (Lele et Gae) and they appear in varying numbers almost throughout the year.

Copepods:

A general survey of Copepods from month to month shows that their peak periods of occurrence are in the months of July and January suggesting thereby two cycles of maxima. They are found in fairly large numbers at the beginning of monsoon and reach their maximum by the end of July, after which the number falls to its minimum by August. From September onwards their population gradually increases again until it reaches its maximum by January of the next year. Some of the commonest species are: *Acrocalanus monachus* (Giesbrecht), *Eucalanus suborassus* (Giesbrecht), *Paracalanus parvus* (Giesbrecht), *Acartia spinicauda* (Giesbrecht), *Centropagesdorsispinatus* (Thompson et Scott), *Centropages typicus* (Kroyer) and *Euchœta marina* (Giesbrecht).

Decapod larvœ:

Copepod naupli are found throughout the year.

Stomatopod larvæ (mostly Alima) are present from August to May and in large numbers in November.

Zœa of Porcellana occur from November to March with swarms at intervals in December.

Zœa of Brachyura is collected from August to April in varying numbers.

Megalopa is taken in small numbers all the year round.

Phyllosoma of Panulirus is present from December to April, largest number being in January.

Larvæ of Prawns are obtained from May to January inclusive. Their number is predominantly large first in the months of July and August, and again in November and December.

Tunicates:

Doliolum and Salpa are the chief forms representing this group in our samples and occur from the middle of October to the end of February. In January and February they appear in very large numbers, at times in swarms. They occurred in unusually large quantity once in October 1942.

Our biological year beginning with the onset of monsoon can be roughly divided into the following four periods according to the variations in the catch. During the rainy season, *i.e.*, June-September, our plankton samples are rather poor both in quality and quantity; but after the rains, *viz.*, from October to December there is an appreciable increase in the catch as more and more transitional planktonic organisms like Decapod larvæ, occur in fluctuating numbers. January, February and part of March seem to be the most favourable months of the year for the occurrence of plankton as swarms of a number of groups of organisms appear at frequent intervals. But during April and May there is a considerable fall in the number of the transitional as well as permanent members of the plankton with the result that the samples taken towards the end of May appear to be meagre.

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Bombay,
May 29, 1945.

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SOME IMPORTANT FEATURES OF THE LIFE-HISTORY OF *STENO-BRACON DEESAE*—A BRACONID PARASITE OF THE SUGARCANE AND JUAR BORERS OF NORTHERN INDIA

Steno-bracon deesæ is abundantly found in sugarcane and juar fields from May to November in the Aligarh District. It is scarcely seen during the remaining part of the year. The male parasites are less active than the females and the percentage of emergence of the former is greater than that of the latter.

The female actively moves on the surface of stems in search of borers. On reaching the exact spot it introduces its long ovipositor into the tunnel, excavated by the borer, and parasitizes it. The egg-laying process is always preceded by the stinging of the host.

The egg-laying process normally does not require more than two minutes. The parasite generally lays only one egg on or close to the body of every host. Under compulsion even nine eggs may be laid in one tunnel within twelve hours. The parasite refuses to deposit eggs on exposed or dead hosts or hosts which have already been stung by another parasite.

Hatching takes place in twenty-three to twenty-six hours at temperatures between 70° F. and 104° F. maximum, the presence of light being necessary. Hatching has taken

place even after the expiry of the normal time for incubation when higher humidity was provided.

The larva undergoes four moults. Each stadium is of twenty-four hours' duration. After fourth ecdysis, cocoon formation starts which requires twenty-four hours for completion. Generally fourth ecdysis and the exhaustion of the host synchronize.

The larva though inside the cocoon is still active and retains larval form till the beginning of the sixth day after fourth ecdysis. At the end of the sixth day it becomes inactive, passes out fæcal matter of brownish colour enveloped within its peritrophic membrane (dejectamenta) and acquires the shape of prepupa. At the termination of the seventh day it casts off the last, *i.e.*, the fifth larval skin. This ecdysis always takes place inside the cocoon. The prepupal stage is of twenty-four hours' duration and ends with the expiry of the seventh day. The prepupa remains enclosed within the last larval skin whose casting off coincides with the process of transformation of prepupa into pupa. The period between fourth moult and the emergence of adults is of seventeen to twenty-one days' duration. The pupa at the time of emergence leaves behind fragments of the cast skin. The total number of days required from the time of egg-laying to the emergence varies from twenty-two to twenty-six days.

During winter, the duration from egg-laying to emergence ranges between forty-six to fifty-eight days at field temperature. In this season the hatching period and the duration of every stage is almost doubled. This aspect of long and short-timed generations has not hitherto been noted in the life-history of either this or its sister species, namely, *S. necevillei*.

It has been observed that the larvæ of the parasite in the stored stems of juar take longer time to emerge than those in the field during winter months. Such cases of delayed emergence in the stores and godowns have been recorded at the end of the following month of March. It may be concluded that the storing is helpful for the repetition of life-cycle of the parasite at the end of winter season every year.

The phenomenon of parthenogenesis is very common during winter and less common in the remaining part of the year.

It has been recorded that the maximum percentage of successful hatching is about 70; while that of emergence of adults from cocoon is above 90; The maximum number of eggs laid by a single female is thirty-two. If a female is forced to lay more than one egg on or near the same host then only one egg is hatched; but on distributing these eggs on separate hosts about 50 per cent. of eggs have been observed to hatch.

The maximum longevity of a parasite both male and female after emergence from the cocoon is fifty-one days. The average longevity of the male is thirty-seven days. This age limit falls down during summer months. The females invariably die soon after they have finished egg-laying. This parasite is very sensitive to unhygienic conditions, hence every care should be taken while breeding it in order to provide healthy environment to achieve good results.

A detailed description of biology, life-history, and morphology of the parasite will shortly be published elsewhere.

The writer is highly indebted to Dr. M. A. H. Qadri for the most valuable and indispensable help and guidance he has received from him while working on this problem. He is also thankful to Prof. M. B. Mirza for permission to use his well-equipped laboratory and for financial assistance.

Department of Entomology,
Muslim University,
Aligarh, SHAH MASHHOOD ALAM.
May 15, 1945.

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THE I. C. I. RESEARCH FELLOWSHIPS AND THE DELEGATION OF INDIAN SCIENTISTS

AT a luncheon held in honour of the Delegation of Indian Scientists, Lord McGowan, Chairman, Imperial Chemical Industries, reported that the Directors of the Company had offered to provide at nine Universities in Great Britain, eighty fellowships of the average value of £600 per annum to be held by senior workers in various branches of science. He revealed that by way of Excess Profits Tax, National Defence Contribution and Income-tax, the Company paid to the British and Overseas Governments a sum amounting to 12·5 million sterling.

Replying to the toast proposed by Lord McGowan, Sir Shanti Swarup Bhatnagar referred to "The I.C.I.'s partiality to their own country". He pointed out that the Imperial Chemical Industries had two big and prosperous factories in India and pleaded "for grants on a generous scale for scholarships for scientific research in India by the I.C.I." This suggestion appears to have immediately caught the imagination of Lord McGowan. While agreeing to consider in a friendly way the question of endowing research fellowships in Indian Universities, Lord McGowan assured the members of the Indian Delegation, that the eighty fellowships in the British Universities would be open to Indian scientists in free competition.

This in short is the "inside story" of the I.C.I.'s farsighted and enlightened munificence now extended to the Universities in India. Details of this Fellowship Scheme are published elsewhere in this issue.

REVIEWS

Synthetic Rubber from Alcohol. By A. Talalay and M. Magat. (Interscience Publishers, Inc., New York, U.S.A.), 1945. Pp. 298. Price $5.00.

This book is a publication on a subject of topical interest. The Russian Planners with great foresight encouraged and financed investigations by their scientists on the production of synthetic rubber from alcohol in anticipation of a war which might cut them off from the sources of natural rubber. The book is a story which tells us how the Russian scientists rose to the occasion. Not only were synthetic rubber plants functioning successfully in Russia when Germany declared war against her; but she was able to render material assistance to U.S.A. when Japan got possession of the natural rubber resources of the East Indies. The authors have rendered a service to the English-speaking scientific world by presenting in a book form the valuable work which had remained inaccessible in Russian literature.

This technical process centres round the well-known discovery of Lebedov that a combination of a dehydrating and dehydrogenating catalyst can give butadiene, in considerable yield, from alcohol. The catalyst and technology have been continuously improved with the result that the yield of butadiene increased from 22 per cent. in 1934 to 41 per cent. (or 70 per cent. of theoretical) in December 1939. Unfortunately the method of preparation of the catalyst has not been revealed; and one has got to remain content with the observation that it is a combination of two materials A and B which may be zinc oxide or aluminium oxide or manganese oxide, etc. The technology of the process, however, has been described in considerable detail. The Emulsion method of polymerising butadiene into synthetic rubber is practised in Germany and other countries but not in Russia; and here valuable information has been given as to how emulsion polymerisation should be done. In Russia, the polymerisation or rather to be accurate, polycondensation of butadiene into rubber is carried out, with the aid of a finely dispersed sodium catalyst "mostly spread thinly over metal shelves or trays".

Besides this Russian work, the book gives general information on the physico-chemical properties of butadiene polymers, *e.g.*, their chemical constitution and molecular weights, X-ray structure and mechanical properties, plasticity, gel formation, oxidation, heat-hardening, viscosity, etc. The treatment of the subject is well balanced—theory and practice —each receiving due share of attention.

It is not surprising that some vital information relating to the production of synthetic rubber from alcohol should have been withheld in war-time for reasons of security, but it is surprising to note that Russian scientists take out patents not only in countries outside Russia but also in their own.

J. C. G.

An Outline of Industrial Metallurgy. By D. G. P. Paterson and J. Bearn. (Chapman and Hall, Ltd., London, W.C. 2), 1944. Pp. 185. Price 12*sh.* 6*d.*

A publication of this kind is of great assistance to non-specialists interested in the manufacture of metals, and also to a Research worker on the latest developments of iron and steel and other important non-ferrous metals. It deals with all aspects of metal working commencing from the smelting of the ore down to the final finishing of all products. Perhaps, another chapter describing details of smelting of iron, steel and more prominent of non-ferrous alloys would have added to the value of the book. When it is remembered that the various processes involved in different stages are exceedingly complicated, the reader will appreciate the procedure adopted by the authors, helping him to have a clear understanding of the subjects.

As metal working requires the use of high temperatures, the importance given to the scientific measurement of temperatures is correctly emphasized. The principal features of smelting and shaping of the metals and alloys are very clearly, though briefly, dealt with. The physical and chemical properties attained by the metals as a result of various treatments are discussed in great detail and should prove immensely useful to all research students and non-technical readers. Methods of thorough examination of the metals and alloys under microscope and X-ray, have been described clearly and the Research worker finds ample hints and notes on the procedure to be followed. Interpretation of the results so achieved, and means of locating and determining the extent of defects in the metallic materials are exhaustively treated.

In these days when the metals are required to satisfy very rigid specifications, and to prove their worth for complete freedom from risk and uncertainty, chapters dealing with this aspect will undoubtedly prove very valuable.

During the last twenty years and especially during the war years, the great importance emphasised on the heat treatment of the metals and alloys is brought out very clearly, and details of different methods of heat treatment for certain types of alloys are set forth. Chapter on Industrial Heat treatment and the subsequent chapters describing among others, latest methods of normalising, bright annealing by cracked ammonia process, hardening and tempering of special alloy steels, nitriding, etc., contain valuable information useful to all engaged on the manufacture of alloy steels.

Till recently one of the chief drawbacks in the larger use of some of these highly specialised alloys was the difficulty in handling them and machining them. These difficulties are being overcome by giving them a special treatment prior to machining, and by the use of special cutting tools—a development of far-reaching importance to Engineering Industries.

Special detailed treatment of aluminium alloys and stainless steels dealt with in two chapters indicates the importance these alloys are playing in the modern-day high class engineering practice. Means of improving the qualities of metals, normally possessing ordinary qualities, have also been dealt with.

The question of repairs to the broken or damaged parts of metals has not escaped the attention of the authors. The different practices such as soldering, gas welding, electric welding have been treated in a very clear manner. Improvement in the technique of electric welding and the development of induction and other means of hardening of parts liable to wear have been clearly described.

Finally, the action of various agents in corroding, thereby shortening the lives of metals is referred to. Some methods of protecting them against corrosion may be traced back to the days when metal began to be used. Remedies have been suggested and adopted from time to time and many of them have limitations. The urge for utilising all the natural resources in the world to the best advantage and the anxiety that the metallic resources will soon get depleted if the present increased rate of consumption continues have led to intensive research on methods of preventing corrosion, and this aspect has been very exhaustively dealt with and the various protecting agents and methods of applying them are described in detail.

Numerous illustrations, diagrams, microphotographs, etc., greatly enhance the usefulness of this publilcation.

D. V. KRISHNA RAO.

You and Your Radio. By Vepa V. Lakshmana Rao. (Addison & Co., Ltd., Madras), 1945. Second Edition (Revised). Pp. 170. Price Rs. 5.

A book for the relatively non-serious students of Radio, who do not care to delve very deep but wish to be entertained and lightly instructed while operating their Receiving sets, has long been needed. *You and Your Radio* by Vepa V. Lakshmana Rao which covers the entire story, fills a distinct want in this direction.

The author has divided the book into twenty-three chapters. Beginning with fundamental lessons and carrying through the Broadcast chain, he follows it up with simple and easily understood explanations of the Radio receiver and its allies. Besides discussions and pictures illustrating points of technique, the book includes a number of art plates covering various aspects of Broadcasting.

The excellent reception accorded the first edition of this book since its appearance in 1942 has prompted the author to undertake this revised edition.

Though largely devoted to the interests of the general reader, this book will provide much useful information to the Radio technician.

C. R. K.

The Rubber Industry in India. By Dr. N. N. Godbole. A.I.M.O. Monograph No. 6. (All-India Manufacturers' Organisation, Bombay). Pp. 24.

This is a cursorily written pamphlet of but 24 pages (4"× 6") of which five are devoted to History, six to Chemistry, four to Latex, and the rest to Rubber Trade and Technology. There is not enough of useful information in any of the sections, excepting perhaps to some extent in the last, and the general usefulness of this pamphlet in this well-known series is very doubtful.

Sargentia—No. V. ***Fragmenta papuana*** (observations of a naturalist in Netherlands New Guinea). By H. J. Lam. Pp. 1-196, with two maps and thirty-two text-figures. Translated from the Dutch by Lily M. Perry. (Published by the Arnold Arnold Arboretum of Harvard University, Jamaica Plain, Mass., U.S.A.), 1945. Price $ 3.00.

This publication of the Arnold Arboretum, being a translation into English of Professor Lam's original Dutch work, has come to be under the stress of war. To-day information is sought for, as never before, regarding poorly known flora of several parts of the globe. Dr. Lily M. Perry's efforts with inspiration from Dr. Frans Verdoorn is, therefore, amply rewarded by the wealth of information she has presented in the volume both topographical and botanical. Dr. Perry's appreciation of Prof. Lam's presentation of botanical enumerations and descriptions and his faithful recording of detail is fully justified by this excellent publication. It would be impracticable to dwell, within the space of this review, on the various botanical details presented therein. Nevertheless, the statistics of the collection given as below may convey an idea of the richness of the flora of the Netherlands New Guinea.

The entire collection of Professor Lam has been placed in 109 plant families. Of the 109 families studied, 467 members represent 285 species, of which 103 are new. In the Pteridophytes the 344 members belong to 204 species, of which 66 are new.

In addition to the description of these plant material the author has very ably presented minute details of the Ecology of the terrain and the occurrence of respiratory roots and pneumatophores in mangrove rattan—hitherto undescribed; of fragrant flowered *Barringtonia* sp.; of other trees with enormous prop-roots, etc. There are excellent sketches of landscape, other drawings of plant material and a good deal of information on Myrmecophilous plants which make reading very pleasant. Publications of this description should find a place in college libraries, for it stimulates thinking in the undergraduate botanist on the modes of describing floras of localities in a country like ours where great patches of vegetation are still largely a *terra incognita* from the botanical point of view.

T. S. SADASIVAN.

SCIENCE NOTES AND NEWS

Messrs Hargolal & Sons, The Science Apparatus Workshop, Ambala Cantt., seek to make contacts with inventors and others who may have ideas relating to designing, improvements or introduction of new scientific instruments and allied products. Main objective is the marketing of improved products or new ideas for instruments for educational science. Ideas may also relate to scientific toys and games. All ideas submitted will be treated with utmost confidence and will be exclusive property of the inventors unless it is adopted by the firm. Further particulars from: Managing Proprietor, Hargolal & Sons, Ambala Cantt.

MAGNETIC NOTES

Magnetic conditions during June 1945 were slightly less disturbed than in the previous month. There were 22 *quiet* days, 7 days of *slight* disturbance and 1 day of *moderate* disturbance as against 20 quiet days and 10 days of slight disturbance during the same month last year.

The quietest day during the month was the 29th and the day of the largest disturbance the 6th.

The individual days during the month were classified as shown below:—

Quiet days	Disturbed days	
	Slight	Moderate
1–5, 11–16, 18–26, 28, 29.	7–10, 17, 27, 30.	6

No magnetic storms occurred during the months of June 1944 and 1945.

The mean magnetic character figure for the month of June 1945 was 0·30 as against 0·33 for June 1944.

A. S. CHAUBAL.

Magnetic conditions during July 1945 were more disturbed than in the previous month. There were 18 *quiet* days and 13 days of *slight* disturbance as against 27 quiet days and 4 days of slight disturbance during the same month last year.

The quietest day during the month was the 27th and the day of the largest disturbance the 17th.

The individual days during the month were classified as shown below:—

Quiet days	Disturbed days
	Slight
2, 9–15, 19–22, 24–27, 29, 31.	1, 3–8, 16–18, 23, 28, 30.

No magnetic storms occurred during the months of July in 1944 and 1945.

The mean character figure for the month of July 1945 was 0·42 as against 0·13 for July 1944.

M. PANDURANGA RAO.

It is proposed to hold the 14th Conference of the Indian Mathematical Society at Delhi during the third week of December, 1945. Authors of papers are requested to send their papers with abstracts to Dr. A. Narasinga Rao, Annamalai Nagar, before the end of October, 1945.

SEISMOLOGICAL NOTES

Among the earthquake shocks recorded by the Seismographs in the Bombay (Colaba) Observatory, there were two moderate and one slight shock during each of the months June and July 1945. Particulars of these shocks have been given in the table below.

1945 Month and Date	Time of origin I.S.T. H. M.	Intensity of shock	Epicentral distance from Bombay (Miles)	Co-ordinates of epicentre	Remarks
June 4	18 39	Moderate	815	Lat. 29° N.; Long. 81° E.	Felt in Delhi and other places in Northern India
14	06 14	Slight	1725		
23	00 30	Moderate	1300		
July 15	12 05	Slight	4680		
22	17 10	Moderate	2035		
23	10 25	Moderate	1815	Lat. 39° N., Long. 53° E. Near Caspian Sea.	

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INDIAN INDUSTRIALISTS' DELEGATION ABROAD

THE Delegation of Indian Industrialists, whose activities in the United Kingdom were briefly recounted in this Journal (*Current Science*, July 1945, p. 165), have now returned home from the United States travelling *via* England. Many of the individual members have been interviewed by the Press on various aspects of their work abroad. The press accounts of the opinions and impressions of the individual members have not always been easy to piece together and at times have tended to be slightly confusing. It was thus necessary to issue an authoritative statement on behalf of the Delegation and this has been now done in the form of an official Report which has been released by Dr. P. S. Lokanathan, Secretary to the Delegation. The Report covers a wide range of problems, some of which, like the political background of the country, the allotment of Dollar exchange and the liquidation of blocked sterling assets, primarily not within the purview of *Current Science*. The following excerpts from the Report of the Secretary are, however, of interest to men of science and technology.

"We were ... enabled in the aggregate to get a general picture of British and American industry, covering an extremely wide range of industrial activity. .... Our impression was that American industry is in many respects well ahead of British industry in efficiency and in equipment used. In the field of research, on the other hand, it seemed to us that Britain was at least as advanced as America. In both countries applied and theoretical research is being conducted on a gigantic scale and money lavished on it by both Government and private enterprise.

"We are much impressed by the improvements in technique and the scientific advances effected in both countries. ..... The immense complexity of modern industry particularly in the engineering and chemical fields ..... have convinced us that if India's industrialisation is to be as speedy as public opinion and her economic situation demand, we should unhesitatingly seek to import ready-made technique and industrial "know-how" from these two and other countries.

"With the possible exception of medium-sized, general purpose machine-tools .... the demand for capital equipment ... is so great that deliveries and prices are bound to be unfavourable for a considerable time. .... There seems to be no chance of getting any (textile machinery) for a long time from America while deliveries from England cannot be expected under two years. In the case of other types of capital equipment, such as power plants, heavy and special purpose machine tools, transport equipment, electrical equipment, mining machinery, forging, foundry and chemical plants, etc., delivery periods vary greatly from six months to two years or more but they are generally longer in England than in the U.S.A.

"We believe that in a couple of years or so prices as well as deliveries will become easier and that the machinery then available will be of a more advanced and efficient type. ... It would be inadvisable for industrialists in India to be in a hurry to purchase capital equipment under present conditions except, of course, where requirements are so urgent or of such a nature that they cannot be postponed. ... We should like to sound a note of warning against the purchase and installation of old and worn-out equipment which would cripple India's capacity to compete in later years. ...

"... of war surplus stock ... being either new or practically new ... prices will range

from 50 to 60 per cent. of their original cost ... we should like to impress upon Government and the business community in India the necessity and urgency of constituting in both countries an organisation which would locate available equipment, inspect and report on it when necessary, canalise all enquiries from India and furnish machinery for their procurement from the various surplus disposal boards.

"We have returned from our trip enriched with first-hand knowledge of the economic and industrial conditions and prospects in Great Britain and the United States and with a better informed appreciation of the significance, scope, needs and complexities of modern industry. We have come back more than ever convinced that only by means of large-scale industrialisation backed by massive scientific research and education, can India hope to emerge from her poverty and distress and rapidly build up the high standard of living to which her people are entitled and so desperately aspire."

This valuable Report does not make pleasant reading to those who believe that the industrial development of India is merely a question of planning on paper, ordering the requisite equipment from just across the counter, install it and begin to collect profits. It is refreshing to notice the emphasis placed by these veteran industrialists that the large-scale industrialisation of the country should be "backed by massive scientific research and education". The Delegation have done a signal service to the country in publishing this Report which is characterised by objective and critical discernment.

COMMODITY COMMITTEES AND COMMUNAL PROSPERITY

IT was indeed a happy moment when the Member of the Government of India for Education, Health and Lands, struck the fruitful idea of creating Commodity Committees for ensuring the education and collaboration of the communities of India for the development of their economic resources. This plan has been welcomed by *Current Science* as an effective instrument for the creation of a new epoch of scientific and industrial awakening in the country.

At the present time five such Committees have been constituted and are in a working condition, namely, The Indian Central Cotton Committee, The Indian Lac Cess Committee, The Indian Central Jute Committee, The Vegetable Oil Committee and the latest addition, the Coconut Committee.

Considering the possible expenditure of public money and material on these Committees and expectations of increased economic prosperity arising from their activities, it seems necessary to review not only their past working so far but also to indicate the general policy which they must pursue in order to realise their full potentialities of development.

At the outset it is necessary to emphasise that in the creation of institutions of this sort, the main object should be to foster an original output of new thoughts, new knowledge and new modes of utilisation of the valuable commodities of India providing suitable opportunities for self-expression of national professional talent in the connected fields of scientific research, skilful industrial and agricultural application of new knowledge and business enterprise required for large-scale production of new products. Obviously the best way of realising this consummation is the organisation of an experimental industrial laboratory for each commodity under the leadership of competent and patriotic leader of scientific research interested in the subject who will be a whole-time officer adequately financed and authorised for the free exploitation and investigation of the industrial and scientific potentialities of the commodity concerned. Without such a nuclear activity it will be useless to expect an adequate economic development of the resources of this country. Judged from this standpoint scientific India can well complain that the current administrative policy has failed to give the scientific Indian researcher the leading place in the constitution and working of these Commodity Committees. On the other hand, by placing commercial and political foreign interests at the head of affairs in the creative realm of future developments for the economic benefit of the country the cart has been put before the horse at too early a stage of our Country's new era of industrial regeneration.

To take one example, the oldest of these Committees, namely, the Indian Central Cotton Committee, has been in existence since 1921 and in a Report of their work during the last twenty years published in 1942, the attention which they have paid to Indian scientific research is so scanty and indifferent that it almost deserves thorough overhauling. Below is quoted a paragraph on "Research Students" from page 31 of the Report in illustration of the importance given to Indian research by this Committee, and of their utter neglect of leading national scientific talent in organising their programmes.

> "In the beginning, the Committee had perforce to undertake the training of research scholars in the various branches of science pertaining to cotton for employment on its research schemes or in the Provincial Agricultural Departments. Gradually, however, the necessity for this has disappeared and scholarships are now, generally speaking, only granted when need for specially trained workers arises in connection with the Committee's schemes or in Agricultural Departments. Sometimes scholarships are also awarded for specialised training at recognised institutions abroad or in the Committee's Cotton Genetics Research Scheme at the Institute of Plant Industry, Indore."

If, on the other hand, there had been a continuous harnessing of all-round National Scientific talent in the elaboration of schemes of research for the adequate utilisation of cotton and its associated by-products, India might be producing by now, commercial quantities of furfural, laevulinic acid, raffinose, tocopherol and a few other valuable industrial products for internal consumption and prosperity (unpublished work of K. Karamchandani under the writer's guidance).

The progress of the Lac Cess Committee during the last fifteen years of its existence exhibits equally depressing features in spite of a large volume of reported investigations both in India and abroad. The root of the depression lies in the fact that Indian workers who were induced to make useful though disjointed contributions to existing knowledge both in India and in London, have never been entrusted with the necessary freedom and authority to consolidate their ideas to their logical consummations. The tendency has been more to fill up existing jobs with indifferent personnel, than to discharge a national responsibility with due consideration of the claims of professional and economic interests involved therein.

The only way to remedy this state of affairs lies in the constitution of a permanent committee of leading Indian scientists of all sciences, pure and applied, who should be authorised by the Government to appoint their own expert sub-committees for each commodity to initiate new schemes of research in relation to the particular commodity, with adequate funds for the creation of necessary laboratory and educational facilities at suitable centres throughout India.

The idea of sending scholars abroad for specialised training with a view to develop our country's resources has very often proved to be more a recreation than a real aid to the creation of suitable opportunities for local scientific talent for the self-reliant organisation of suitable programmes of research. It should be remembered in this connection that in spite of ignorant and ignoble attempts by interested parties to disintegrate the scientifically organised communal solidarity of India, the communities in India have still not lost their hereditary and inborn professional responsibilities and efficiencies. The disinterested research scholar, the public-spirited administrator, the philanthropic businessman and landed aristocracy, and the self-respecting skilled artisan are still alive in India, each with his inborn professional intuitions and equipment. It should be the sole aim of each Commodity Committee to bring together the goodwill and enthusiastic co-operation of members of each of these four communities into active collaboration in an experimental research laboratory intended for the exploitation of the industrial potentialities of each of the valuable commodities of India.

In the writer's opinion there is no half-way house between a free and full communal prosperity for India and the necessity for the establishment of laboratory facilities for the mutual understanding and planned collaboration of members of the professional communities of India in the cause of the economic utilisation of our country's material resources in the immediate future.

It is therefore, earnestly hoped that before long, there will be a definite change of orientation of policy in the working not only of the present Commodity Committees, but also of others that are likely to come into being in the near future, so as to make these organisations real and powerful instruments for the creation of National outlook, professional personnel, and economic communal prosperity.

P. Ramaswami Ayyar.

SIR A. L. MUDALIAR

The appointment of Sir A. Lakshmanaswamy Mudaliar as Vice-Chancellor of the University of Madras for a second term of office is an event which gives the deepest satisfaction to educational circles in South India. At this time when many problems relating to University Education await solution, the Madras University is fortunate in having one of the foremost of Indian Educationalists at the helm of affairs to guide her destinies.

After graduating from the Madras Christian and Medical Colleges, Sir Lakshmanaswamy began his career as a member of the Provincial Medical Service and was connected with the Government Hospital for Maternity and Child Welfare, Madras. He joined the hospital as an Assistant and later rose to the position of its Chief. The very high standard of his work and scholarship earned for him a front rank in the medical profession as a leading authority on Obstetrics and Gynæcology. He contributed much to the scientific side of his subject, wrote a well-known text-book, and trained a large number of medical men for professional as well as scientific work. All this was duly recognised by his election to the Fellowship of the Royal College of Obstetricians and Gynæcologists, England. His scientific enthusiasm did not minimise the human interest he took in his work; all through his career, when administrative responsibilities of various types weighed heavily, he found time to continue his professional work and maintain contact with the Hospital to which he was so long attached and for which he did so much to develop it as the leading Institution of its kind in India. The medical profession in South India also knows him as an inspiring teacher, for he was Lecturer and later Professor of his subject at the Madras Medical College. His appointment in 1937 as Principal of the College was a notable event, as it marked a departure from custom, he being the first Indian to hold this key position of medical education in South India.

Sir Lakshmanaswamy's connexion with the Madras University dates from about twenty-five years ago, as a member of the Academic Council and the Senate. His deep study of University problems soon found him in the front line of University administration and in the Syndicate, whose membership he held without interruption. The period of his active work at the University with successive Vice-Chancellors, particularly from 1930-1940, was one of the most fruitful periods of expansion of its activities, in the starting of the different Research Departments and adequately housing them in the University area. Along with the then Vice-Chancellor, Sir K. Ramunni Menon, he took the keenest interest in the starting of the three Scientific Laboratories of the University, *viz.*, Botany, Zoology and Biochemistry,

in 1933. He acted as Vice-Chancellor in 1941 and was elected for his first term of Office in 1942.

The first term of Office recently completed by Sir Lakshmanaswamy is noteworthy for the great interest which the Madras University took in fostering Technological Education in South India. The importance of Technical education so as to train suitable personnel for industrial work has been stressed in our columns from time to time. Chemical and allied industrial development has been particularly backward in South India owing mainly to the absence of suitably equipped training centres. With his characteristic zeal Sir Lakshmanaswamy took up this cause and succeeded in enlisting the support of the Government and a leading Industrialist, Dr. Alagappa Chettiar, with the result that it was possible, with the co-operation of the Government Engineering College at Guindy, to open a College of Technology in 1944. This College began with courses in Chemical Engineering and has already developed further with arrangement for courses in Textile and Leather Technologies, subjects of special interest to industrial development in South India.

Among the other achievements of the Madras University during this period, particular attention should be drawn to the starting of new graduate courses in Commerce and in Nursing, and to the organisation of short-term post-graduate courses for the Medical Profession.

In the various reconstruction programmes for this country, Sir Lakshmanaswamy has already put in much notable work on the Health and Survey Committee of the Government of India, as the Chairman of the Educational Reconstruction Committee of the University of Madras and as Member of many of the Committees constituted by the Government of Madras. Our very best wishes go to him for the success of his future work and the continuation of the sound and energetic policies on Educational and Medical problems that have so characteristically come from him.

ECONOMIC UTILISATION OF SHARKS IN INDIA

BY

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SHARK LIVER OIL industry in India to-day represents one of the war-born industries, whose survival capacity during the post-war period is solely dependent upon the extent of support which the industry would receive from the Central Government. The industry when consolidated and developed would not only afford employment to tens of thousands of fishermen but also provide a supplementary and desperately needed source of nourishing meat and a rich and exclusive source of an indispensable group of vitamins; in addition, other portions of the carcass now discarded could be made to yield a wide variety of valuable products: hides, active principles, biologicals and fine chemicals. As in the case of herds of cattle and flocks of sheep, the sharks need not be raised; they breed naturally in the depths of the coastal waters of this sub-continent; controlled fishing and scientific management of sharks will ensure a steady supply of this raw material. The sharks, if properly utilised, will serve to conserve the cattle wealth of the country, which has got depleted to an alarming extent during the war period. These are circumstances of compelling significance which entitle the industry to every form of Government support and protection.

In consideration of the national importance of the industry, the Central Government may be expected to grant adequate protection against aggressive foreign competition and extend generous financial support for the prosecution of researches on the fundamental and technological aspects of the industry.

At the moment, the shark liver oil industry, which has made some promising headway during the war, is overshadowed by the complacency, the uncertainty and the indecision which constitute a lamentable feature of post-war planning in this country and by the imminent commencement of the whaling operations by Anglo-Norwegian interests as revealed by a recent broadcast. The threatening aspect of this enterprise becomes apparent if attention is called to the recent discovery that the whale liver is the richest source of "Kitol" which on simple distillation gives vitamin A; This is a direct challenge to the shark liver oil whose recognition as one of the richest sources of vitamin A is largely due to the pioneering investigations of Dr. Sunder Raj and his collaborators.

Since 1940, the Departments of Fisheries in the several maritime Provinces and States have intensified their efforts and achieved a substantial measure of progress in the production of shark liver oil; some of them have also investigated the process of filletting and curing the edible portions of the shark by improved methods. We have not been able to secure reliable data ragarding the annual production of shark liver oil in the country; much less have we been able to obtain information with regard to the total number or weight of sharks caught from the coastal waters of India. Setna[1] (1945) is of the opinion that during the past 4 years an output of a million and a half pounds of oil may not be an extravagant claim. Considering the widespread prevalence of night-blindness and general malnutrition in this country, and assuming that an average deficiency (computed on the entire population) works out to about 20 per cent., the country's requirement of shark liver oil of 10,000 I.U/per gm. potency, will amount to about 28 million pounds per annum. Taking 100 lbs. of liver as the average yield per shark, and assuming that 50 per cent. is the average yield of the oil, it can be calculated that 576,000 sharks will have to be caught per year to satisfy the

urgent human requirements of vitamin A; we have not taken into account the vitamin A deficiency which is believed to be alarmingly widespread among our cattle.[2] Whether our seas could sustain this rate of depletion of sharks, is a point on which expert opinion will have to be elicited.

The total weight of the catch will amount to 576,000 × 1,500 lbs., *i.e.*, 432,000 short tons. The utilisation of the carcass would thus present a problem of considerable magnitude and economic value. The shark, as indicated before, provides, in addition to the oil, other exploitable products. We could not get at any data pertaining to the relative weights of the various organs and tissues which could be obtained by dressing the carcass of a shark. One of us (I.M.G.) has taken up a study of this question and preliminary studies have revealed that the following percentages (Table I) of the more important organs and tissues could be obtained. We have not been able to obtain data with regard to the ductless glands, which might ultimately prove important sources of hormones. We understand that Dr. B. B. Dey, who has done pioneering work in this field, is already engaged on this problem.

TABLE I

Percentages on the body-weight

(All weighings with fresh material)

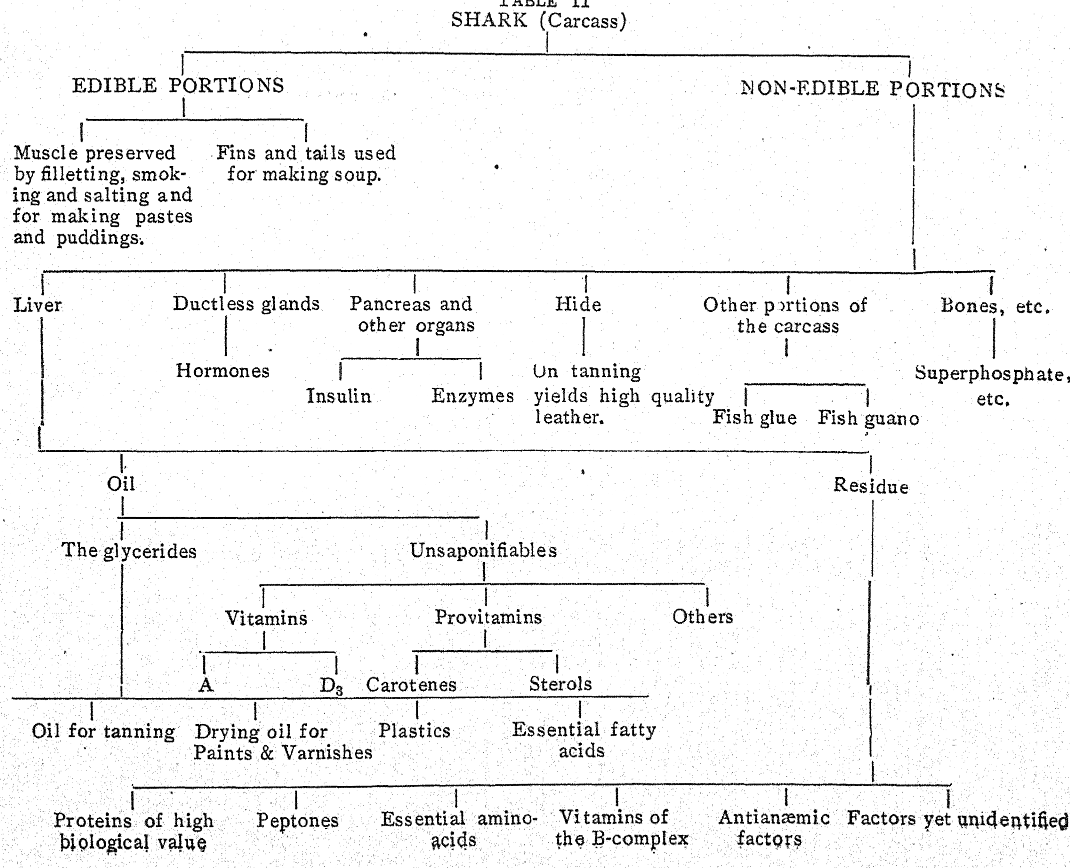
Muscle	45·2	Stomach	2·2
Hide	12·9	Intestines	1·0
Head and Bones	24·2	Blood	0·8*
Fins and tail	6·1	Pancreas	0·32
Liver	3·3	Heart	0·12
		Kidney	0·03

*Obtained by bleeding

It will be seen that the annual catch of sharks amounting to 432,000 short tons would give not only the oil for which they are now fished but also considerable quantities of byeproducts which could be processed into a variety of useful materials. The accompanying chart (Table II) will serve to illustrate the scope of these byeproduct industries. Nutritious meats of high biological value from muscles (shark flesh pastes and puddings), hides of exceptional quality and strength, glues and gelatines from fleshings and sinews, proteins, peptones and amino-acids from nitrogen-rich organs and tissues, hormonal extracts from ductless glands, antidiabetic harmones from the pancreas, and vitamin rich concentrates of high antianæmic value from the liver, represent the more important groups of products which portions of the shark carcass (at the moment mostly discarded) could be made to yield.

The meat consisting principally of the muscle of the sharks and the rays, especially those with black-tipped fins, *Carcharinus limbatus*, *Carcharinus bleekeri*, is now being utilised. Small-sized *Carcharinus melanopterus*,

TABLE II



Sphyrna zygœna and *Carcharinus menisorrach* are consumed fresh and are generally administered to women after child-birth. Setna[1] (1945) has recorded that shark flesh is at present being filletted and salted in the fish-curing yards all along the coasts of Bombay and Madras. The product is said to find a ready market in the interior. Recently smoking of shark fillets has been undertaken and the process has been found to give a satisfactory product. Even the fins and the tails of the larger varieties of sharks are considered edible when made into soup; formerly large quantities of this material were being exported to England, Germany and China.

The skin of the shark can be tanned to an extremely useful leather[3] (1922); at the moment, there does not appear to be any organised attempt in this country to utilise this valuable byeproduct. Cameron[4] (1937) has recorded an exceptionally high content of iodine (1·160 per cent.) for the desiccated thyroid glands of certain fish. The possibility of manufacturing potent preparations of insulin has been suggested; many fish possess pancreatic glands which have been found to contain exploitable quantities of this invaluable hormone. According to Tressler[5] (1923) various species of sharks have been examined to determine their relative value as potential sources of insulin. The shark has been found to contain this active principle in a form which can easily be extracted. In these directions, practically no work has been carried out in this country.

We have completed a piece of investigation directed towards the utilisation of the liver residues of the shark as a source of peptones and amino-acids on the one hand, and on the other, of the vitamins of the B-complex, anti-anæmic factors and other physiologically active principles. With regard to the other organs practically no work has been carried out; it is of utmost urgency that work in this direction should be extended immediately; it will serve to lay the foundation for the establishment of a chain of interdependent industries, which together, would contribute towards the stabilisation of the shark liver oil and allied industries.

1. Setna, *J. Sci. Industrial Research*, 1945, **3**, 303. 2. Fernandes, *Indian Farming*, 1940, **1**, 591. 3. Rogers, *Practical Tanning*, 1922, page 574. 4. Chr. Bomskov. *Methodik der Hormonforschung*, Bd. I, 1937, page 311. 5. Tressler, *Marine Products of Commerce*, 1923, page 693.

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STORAGE OF FOODGRAINS

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IN normal times, the supply and demand for foodgrains and their products could be so adjusted as to entail the holding of minimum stocks for a minimum period of storage. Under conditions of war or of threatened famine, the shortage of foodstuffs in general necessitates the maintenance of large stocks and quite often for longer periods. Even in ordinary times, the storage of food-products has presented many problems in countries where climatic conditions favour generally the deterioration of such materials. This deterioration is usually associated with either a high atmospheric humidity or a high moisture content in the stored product. Humidity and moisture are thus primary factors which control insect attack and mould growth in the stored materials. Besides these, the conditions of storage as well as the conditions in which the grains are received are important factors which determine the loss of foodstuffs in a locality. The problem of storing foodgrains and food-products is thus important requiring close scientific approach for its study. In the present review, it is proposed to summarise the available knowledge on this problem and suggest a simple and practical method for adoption, whereby the loss of foodgrains may be reduced to a minimum.

CONDITIONS FOR STORING FOODGRAINS

Foodgrains such as cereals and pulses have certain fundamental characteristics. In the first place, their moisture content is not a fixed entity but is conditioned by the humidity of the atmosphere in which it may be stored. Thus depending upon humidity, the grains take up or lose water. According to Snow[1] *et al.*, cereals take up more moisture than pulses (legumes) at a R.H. of 40-80 per cent. Above 80 per cent. R.H., this absorption is reversed. Gane[2] arrived at similar conclusions independently. The former investigators have, however, recommended safe levels of moisture content for storing different feeding-stuffs. Thus, a moisture content of 15·7 per cent. is the safe limit for short storage of wheat (about three months) while it may be 14·6 for longer periods (over one year). In the case of maize, this safe limit has been fixed at 12·5 per cent. for export purposes. In respect of stored grains, the factor of safety varies to some extent with the different types of products, but broadly it may be fixed at 12-14 per cent. moisture for satisfactory storage, although it could be conveniently lower than this. Secondly, grains with a moisture content of 15 per cent. and above, have a tendency to "heat" up, a feature which is not very desirable, as it affects the quality of the grains. Thirdly, with a moisture content of 15 per cent. and more, conditions are favourable for insects to feed and breed on the material. This is then followed by mould infestation. Wheat, with a moisture content of 17 per cent., has been found to be readily infested by insects, particularly weevils. It must be emphasised here that it is not merely the moisture content of the stored grain, but the R.H. of the atmosphere surrounding the grains is equally important. It is not adequately realised that grains reach equilibrium with the atmosphere and absorb or give up

moisture depending upon the humidity of the air. According to Barton-Wright and Tomkins,[3] mould growth was prevented on flour exposed to a R.H. of 79 per cent. and on bran to a R.H. of 75 per cent. during a period of four months' storage. In discussing the influence of humidity on storing feeding-stuffs, Snow *et al.*,[4] concluded that mould development was conditioned generally by: (1) the R.H. of the atmosphere. (2) The temperature of storage. A humid atmosphere and a temperature of over 20° C. favour strong mould growth. (3) The length of storage period. At a R.H. of 75-100 per cent. mould growth takes place very soon, while below 75 per cent. R.H., the development of moulds is extremely slow though not inhibited. (4) By the type of moulds. In discussing the effect of humidity on insects Germar[5] observed a mortality of 100 per cent. weevils in two days at a R.H. of 20 per cent. and in twenty-two days at R.H. of 100 per cent.

It is evident from the above that the moisture content of the grain at the time of storage and the humidity of the air to which it is exposed are two essential factors requiring careful control if insect and mould attacks are to be avoided during storage. It may be mentioned here that where grains are treated to reduce their moisture content to 10 per cent. or less, weevils are unable to attack such products, and where they are particularly excluded from air as well, the insects cannot carry on active life. Under such a low moisture content heating of the grains does not take place. Loss of grains during storage is thus avoided. The question of dehydrating grains to reduce the initial moisture content to the safe limit has to be considered both from the view-points of the moisture content of the same as well as the atmospheric conditions during such drying. It is obvious the dehydrated material should not be exposed to a high humidity, as water will be absorbed by the grains. Thus, in Burma, it has been observed that rice milled in the dry season, keeps better than that milled in the wet season. Where the reduction in moisture content is small, heating may be resorted to, since the cost involved is not much. Where the grain is highly infested or where it is otherwise very moist, the removal of moisture by heat may not be a profitable one. Thus, in experiments conducted in W. Indies and Mauritius, the doubtful economy of such a procedure was indicated.

Besides controlling the moisture relations of the grains intended for storage, the successful storage of foodgrains involves in the fulfilment of two other essential conditions, *viz.*, (*a*) that the produce to be stored is in a condition suitable for storage at the time of introduction into stores and (*b*) that during the period of storage conditions are established whereby the grains are rendered free from infestation. While it may be possible to treat infested and damaged grains so as to minimise damage, it would be preferable to prevent loss by attention to the provision of suitable stores and to conditions of storage. As a rule, grains are bought in new unused bags in order to minimise infestation from used bags. But there is no guarantee that the grains are primarily examined or tested for freedom from insect attack. Then again, during transport by rail or carts, infestation is not prevented. A great deal of attention is necessary by the transporting authorities in this connection. This primary infestation prior to storage must adequately be prevented. The secondary infestation takes place during storage.

It is clear from the above that in respect of storing foodgrains, the two essential conditions referred to above must be rigorously attended to. It is known that grains are easily attacked by a large variety of insects, such as grain weevils, beetles, flour beetles, flour moths, mites, etc. It is not proposed to consider the insects except in relation to their habits and behaviour to explain the methods of controlling them. In regard to the first condition mentioned above, where grains are intended to be stored for long periods and in large quantities, it would be wise to screen it first so as to eliminate the adult insects as soon as possible after receipt of the same. The material so treated is in a better condition to store inasmuch as the adults—weevils, etc.,—are prevented from laying eggs. The damage resulting from future infestation is largely minimised in this way. The longer this screening is delayed, the greater will be the infestation. In other words, the infestation brought in by the goods to be stored—"the "incoming" population—is more easily controlled than the "resident" population, *i.e.*, the infestation during storage. The former treatment is more easily achieved. In cases of heavy infestation, screening the goods followed by dehydrating to the safety level of moisture referred to in the beginning, would ensure satisfactory conditions and render the grain fit for storage. In this connection, the question of treating containers like gunny bags, in which grain is normally transported, is a very important one. These should be sterilised either by dry heat, sun or by the use of boiling water, before being used again. The rooms wherein the bags were stored with the grain, should be well cleaned and fumigated.

In the matter of storing grains free from insects, this is largely achieved by adhering to conditions of hygiene and to selection of proper storage containers, such as bins for bulk storage. These must be free from holes, crevices, angles, etc., wherein insects reside largely. These bins are capable of being fumigated and sprayed with chemicals, after the contents have been removed. They are capable of being closed airtight so as to prevent contact with the outside air. It is common knowledge that grain weevils and moths thrive best in darkness and in a still, warm atmosphere. Therefore good light and thorough ventilation are generally recommended for storing grains in bags. These are elementary precautions in the storage of grains. When the bins are cleared of their contents, all rubbish and refuse from the stored product should be swept up and completely destroyed. It is not uncommon that such refuse grains are often taken back to the stores just to avoid report of loss on

storage. This dangerous practice cannot be justified on any account. The regular movement of stored grains also acts as a check on the multiplication of moths and weevils. The mixing of fresh stock with that in storage should never be recommended without thoroughly examining both for freedom from infestation. The question of containers for long storage is engaging the attention of authorities in this country and is outside the scope of this article.

The Control of Insect Pests of Stored Grains

In actual practice, the enforcement of the conditions referred to previously, leaves much to be desired, so that infestation of grain by insects and subsequently by moulds has not been eliminated either prior to storage or during storage. In this country, storage of grains is generally in bags and it is only now that the different governments are planning to adopt bulk storage in bins, etc., and control infestation by long-established methods in vogue here and abroad. Infested grains have been subjected to physical treatments such as heat, X-ray, etc., on the one hand, and to fumigants on the other. The former procedure has not been of much avail because of the cost involved in "de-weevilising"* and in reducing the moisture content of infested materials, which are highly moist—the greater the degree of insect attack the greater is the moisture content of the grain. The employment of fumigants has been widespread and much literature has grown on these. Beside these two processes, a simple method of coating grains with certain "inert" dusts has recently been evolved—more in the nature of a prophylactic or protective treatment than a curative one, which the other two are.

In treating infested grains, the degree of infestation is the most important factor, so that each bag or bin must be closely examined by a competent technical staff. In very incipient stages of infestation or where infestation has just commenced, it may be wise to screen the material and subject the residue to a high temperature for a short interval, or *vice versa*. Considerable care is necessary, where heat treatment is to be resorted to. Normally, the ryot exposes the grains to the action of sun's rays for a day or two, winnows the material and stores again. In this way, he is partially dehydrating in addition to removing the insects. Where larger quantities are involved, some form of commercial dryer is needed. During the last War, a mechanical equipment—known as Hess Dryer and Cooler—was evolved in England to process infested grains. In this drier, the infested grain was reconditioned, improved and further damage prevented by subjecting such material to a blast of hot air followed by one of cold air, the grain being dried in this process, most of the mites killed and their bodies recovered. In the Hess Drier and Cooler,[6] "the grain is passed from a band conveyor into a garner where it falls into a chamber containing a series of horizontal racks arranged one above the other, zig-zag fashion. After subjecting it to a hot air blast, the wheat passes into a similar chamber and receives a blast of cold air; then it passes into a hopper beneath and thence is discharged on to a band conveyor. Cold air is drawn through the lower chamber by a powerul fan, is forced over a series of steam coils and then passes over the wheat in the upper chamber". Here heat serves as a sterilising agent, the temperature recommended not exceeding 150° F. which does not affect the quality of the grain. It is never advisable to go above this temperature which is fatal to all insects. This method had been in vogue in U.S.A. and in Australia. The difficulty is one of adequate equipment and the possible repetition of heat sterilisation more than once, should reinfestation set in during storage. In high temperature treatments, the difficulty is again to decide upon the range of temperature non-injurious to the grain but fatal to the contained larvæ. Generally 140° F. is enough to kill all insects but five minutes' exposure to a temperature of 125° F. is just as fatal. For seeds, a temperature of even 150° F. does not affect germination. It is probable that higher temperatures would impair the quality of the grain, affect the baking quality in the case of flour from wheat. In the highly moist condition, depending upon the degree of infestation, denaturation of the proteins cannot be eliminated. Again, the heat treatment has to be carried out when the outside temperature is high. Although heat treatment of grains has not been generally favoured, it may be mentioned here that recently the application of electronics or high frequency current to processing grains has been reported. It has been observed that a temperature of 120-130° F. is easily attained by a 3 kw heater and an exposure of 20-30 seconds seems to be more than adequate for the purpose. The equipment for this process is also less complicated. The generation of high frequency current of at least 100,000 cycles would be required. It has further been observed that the cost of this process is mainly that of generating this frequency.

Control through Fumigation

The only radical method of ensuring freedom of grains from pests is sterilisation, *i.e.*, subjecting the grains to the action of a lethal agent. Although a fumigant is not a lethal agent, the difference between the two is very small. Both should, however, not impair the quality and flavour of the material treated. A fumigant does not affect the grain, but must possess good powers of penetration, be non-inflammable and be without harmful effect on the operators. It is essentially a chemical process and has been favoured all the world over. In the selection of a fumigant, the following conditions are essential. Primarily, the fumigant should be violenty toxic to insects only. It should be easily and cheaply generated and should not readily condense to a liquid medium. It should have great powers of diffusion and be insoluble in water as far as possible. The vaporization of the fumigant is the most important factor to render it thoroughly effective. The main cause of failure of fumigants is traceable to the sorption of the same either by the stored product or in the walls of

* This expression is employed to connote the removal of insects in general.

the fumigation chamber, whereby a large part of the vapour is rendered inactive. Hence ample allowance must be made for this sorption. What is sorbed by the foodgrain has little or no insecticidal effect. Therefore, the lethal concentration effect of the fumigant must be maintained after allowing for this factor. This aspect of the problem has recently been considered by many investigators. It is necessary to refer to the article of Oxley and Rowe[7] in this connection. Ordinarily, the atmospheric concentration around the insect is more important for practical purposes than the amount employed or taken by the insect. Thus according to Winteringham,[8] "in fumigation practice, the dosage of a fumigant required has often to be found by trial and error. Available data frequently express dosage in pounds per 1,000 c.ft. of chamber, which means that the dosage is based on the capacity of the chamber alone and does not allow for variation in the proportion of the fumigant sorbed by the product treated. This proportion is considerably affected by such factors as the nature of the product fumigated and temperature. The proportion of the fumigant sorbed by the product is sometimes very large. For example, during the fumigation of 140 lbs. bag of wheat feed with ethylenedichloride in a 500 L chamber, no less than 90 per cent. of the fumigant was sorbed by the wheat-feed, leaving only 10 per cent. available in the free air space for killing any infesting insects. The data obtained on the sorption of ethylenedichloride by various products have enabled dosage and distribution of the fumigant in the sorbed state to be estimated and have provided certain information about penetration, aeration and the nature of the residual fumigant". The higher the quantity of the fumigant sorbed by the feed, the larger the time needed for removing the same. Besides these, the successful fumigation of a product in practice, requires that (1) the bins or other containers employed must be capable of being closed tight; (2) the product must be warm enough, preferably at a temperature of 70-75° F. Better results are reported at 85-90° F.; (3) the bin doors must be sealed air-tight; (4) the fumigant should be applied by removing it from the original containers; (5) it is best to cover with a tarpaulin or with sacks, the surface of the product to be treated; and (6) the breathing of an excess quantity of the fumigant should be avoided. These are public health regulations requiring handling and manipulation by a technically trained staff. In this way alone, the hazards incidental to fumigation are minimised, if they could not be eliminated altogether.

Several fumigants have been in use. HCN gas or cyanides (6),* Carbontetrachloride ($^1/_{10}$), Carbonbisulphide (1), Ethyleneoxide (3-5½), Ethylenedichloride (¼-$^1/_3$), Chloropicrin (2½-3), Methyl Bromide (7), Methyl and ethyl formates (1¼), Trichloracetonitrile, have been recommended as fumigants. According to Shafik,[9] the order of toxicity of the fumigants together with minimum dosage (in c.c. per litre) for a 100 per cent. kill is as follows: Isopropyl chloracetate 0·008, Methyl chloracetate 0·01, Ethyl chloracetate 0·02, Ethylenedichloride and CCl_4 mixture 0·05, Ethylenedichloride and Trichlorethylene mixture 0·18, Ethyl formate and CCl_4 0·10, CS_2 and CCl_4 0·14, CCl_4 0·18, and Trichlorethylene 0·13. It will be seen from the above that a mixture of ethylenedichloride and carbon tetrachloride has been recommended and widely adopted. This mixture has all the good effects of an ideal fumigant mentioned above. The literature on fumigation is extensive and the following summary of the existing knowledge is included here.

The type of insects infesting grains is varied and includes moths, weevils, beetles, etc. Apart from this, we have to deal in each case, with the eggs, pupæ, larvæ and adults. One encounters in infested grains, at one and the same time, insects at all stages of development. Hence the fumigant employed must be effective equally on all the stages—which is unfortunately not the case. The action of fumigants on insect varieties also varies as can be seen in the following table:—

Median lethal conc. of fumigants for the confused flour beetle and the grain weevils:

Temp. 25° *C. Time of exposure* 5 *hrs.*

Fumigant	*T. confusum* Flour beetle	*S. granarius* (Granary weevil)	*S. oryzæ* (Rice weevil)
Hydrocyanicacid (HCN) ..	0·6	5·8	-
Chloropicrin	4·6	5·0	2·0
Methyl Bromide ..	11·2	7·6	4·0
Ethylene oxide ..	18·0	5·6	5·7
Methyl formate ..	23·5	20·0	—
Ethyl formate ..	24·5	25·0	17·5
Ethylene dichlinde ..	37·5	38·0	31·0
Carbonbisulphide ..	61·0	40·0	26·0
Ethylacetate ..	83·0	86·0	49·0
Trichlorethylene ..	108·0	335·0	196·0
Carbontetrachloride ..	185·0	360·0	160·0

(Expressed in mgs./L to effect 50% mortality)

From the data presented above, it is obvious that the toxicity of a fumigant varies in quantity from one kind of insect to another. The granary weevil is more resistant to fumigants in general than the rice weevil. These figures were obtained with commercial fumigants and are only relative. According to Shepard *et al.*,[10] two closely related species like *S. granarius* and *S. oryzæ*, are likely to "show the same relationship of toxicities throughout a considerable series of unrelated compounds."

Even in the same insect, the egg stage is commonly believed to be more resistant to a fumigant than other stages. Also a particular insect stage may be more resistant to some fumigant than to others. There is, however, no correlation between the respiration rate of insects at particular stages and a fumigant as is commonly thought.

* The figures in brackets refer to dosage needed on the basis of carbondisulphide as one unit according to an Australian worker.

Median lethal conc. of certain fumigants on different stages of the flour beetle. Temp. 25°C.

Fumigant	Egg	Larva	Pupa	Adult	
				Young	Old
Carbonbisulphide	147	60	136	110	63
Chloropicrin	45	3·5	9·1	4·3	4·4
Ethylene oxide	2	11·0	19·5	—	18·0

Here the adults are killed at about half the dosage of CS_2, or about $^1/_{10}$ the dosage of chloropicrin needed to kill the eggs, but they are 9 times as resistant as the eggs to ethylene oxide. Thus the fumigant effective against adults or larvæ may not be useful for killing the eggs. Also, the egg stage of certain insects may be more resistant to some poisons yet less so to others.

Further, geographical location is a factor operating likewise on insects, according to Lindgren and Shepard.[11] Apart from this, each stage of the insect differs in susceptibility at different periods of development. These specific differences in susceptibility to a fumigant are normally due to the differences in fatal dose but it is also possible that one species of insect may sorb more fumigant from a low concentration, while a second one may sorb from a higher concentration. Thus, rice weevils relatively resistant to HCN sorb only 0·444 mg. per gram of body-weight from a conc. of 77 mgs. in 10 mins. The question, therefore, is one of ready sorption of the toxic fumigant by a species of insects.

In recommending this method of treating infested grains, greater consideration must be given to hazards arising from the use of such toxic chemicals. Primarily, the human skin absorbs almost all the chemicals as shown by McCord.[12] It is also pertinent here to refer to the work of Wirtshafter and Schwartz,[13] reporting acute ethylenedichloride poisoning. It is, however, possible to overcome fire hazards in a suitable manner, such as diluting the fumigant with a noninflammable material like CCl_4. But the more important fact is the "residual" effect or sorption of the fumigant by grains and other food products. It is well known that only a certain quantity of the fumigant can exist as vapour without exerting pressure on the walls of a chamber or bin. In order that a fumigant may act on the insect, the atmospheric concentration around the insect is more important than the amount taken by the insect itself. Humidity also plays a large part in this. The sorption of a fumigant is about eight times that without flour or other absorptive material. It may be roughly stated that the higher boiling fumigants are most highly sorbed.

Where the fumigant is sorbed both by the stored product and by the insect in large amounts, the quantity of the fumigant necessary to maintain the lethal concentration in the air around the insect will be much more than what has been reported till now. This point has been stressed by Oxley and Rowe

Sorption ratios for various fumigants in presence of flour (Temp. 25° C.)

Fumigant	Lethal Concentration in mg./L		Sorption Ratio	B.P. °C.	Vapour pressure mm. 25° C.
	No sorbent	Flour			
Methyl bromide	10·2	21	2	4·5	760
Ethylene oxide	15·5	96	6	11·0	760
Hydrocyanic acid	—	—	2	26·0	739
Methyl formate	18	78	4	32	—
Carbon disulphide	64	147	2·5	46	361
Ethylene dichloride	46	240	5	84	80
Chloropicrin	3·9	35·5	9	112	24
Tetrachlorethylene	54	440	8	120	—
Methyl thiocyanate	1·4	16	10	130	—

(*loc. cit.*). According to Winteringham, in a bag of 140 lbs. wheat, to secure a final concentration of 62 mg./L of ethylene chloride in the free space, 455 grams of the fumigant for a 500 L chamber were needed for an exposure of 48 hours at 20° C. Similarly, for a bag of 100 lbs. in order to maintain a conc. of 36 mg./L, 58·5 gms. of the same fumigant were required. The conditions influencing the sorption of a fumigant also vary. Thus the lower moisture content of the grain, the less is the sorption of the fumigant. The quantity of ethylenedichloride sorbed by one variety of wheat is reproduced as read from the graph of the paper by Winteringham (*loc. cit.*).

Sorption of Ethylenedichloride (*p.p.m.*)

Conc. of the fumigant	Time in hours		
	24	48	168
10 mg./L.	150	200	250
100 mg./L	1750	2000	2600
200 mg./L	3600	4000	5600

The only advantage in using ethylenedichloride mixture is, in the opinion of Shafik,[7] that it could be used safely for fumigating materials with a high water content, *i.e.*, in a heavily infested condition, or "in places where free water content cannot be excluded". In the opinion of others, "these mixtures are, however, unstable and not satisfactory". They are all fat solvents and so are not suitable for fatty materials.

p-Dichlorobenzene is a good seed disinfectant but it leaves a taint in the grain which does not, however, affect germination.

In fumigation practice, it is safe to provide gas masks for the workmen. First Aid provisions must normally be available.

Protective Coating with Insecticidal Dusts

The employment of protective dusts for storing grains free from insect pests is an agelong practice in various countries. Slaked lime has been used to the extent of even 5 per cent.

on the quantity of foodgrains. Chalk powder at the rate of 1 per cent. by weight, has also been used. Very fine dry soil has served more effectively in India and other countries. The protection afforded in many cases may merely be mechanical, in that the grain is covered and hidden from attack. The interest in the use of dusts has recently been aroused by the application of a large number of "inert" dusts including magnesia, silica as mentioned by Peters.[14] The availability of finely ground quartz, as a proprietary product "Naaki" aroused further interest in England and other countries. Zacher[15] suggested that the dusts acted on the insects as a desiccant. Chiu[16] reported the action of silica on the bean weevil in relation to particle size. These dusts have no effect on the physiology of the insect such as clogging the spiracles. But all the insects were found to clean their bodies vigorously with legs, mouth-parts and antennæ. If the killing of the insects was a desiccation process, it is natural to suppose that they would be most effective at low humidities. This was shown to be the case, by Germar. In his experiments, a mortality of 100 per cent. of the granary weevils was observed in two days at a R.H. of 20 per cent.; in three days at 45 per cent. R.H., in seven days at a R.H. of 80 per cent., while at 100 per cent R.H., it took 22 days for the insects to be killed. The temperature was 25° C. Apart from mere desiccation, the action of the dusts may be due to an irritation of the intestines. In Egypt, a product known as "Kattelsousse" prepared from ground rock-phosphate and sulphur has been sold by the I.C.I. on behalf of the Egyptian Government. This material has been used at 1 per cent. on the weight of the grain. Narasimhan and Krishnamurti[17] reported the use of scorched paddy husk for the same purpose. The ground husk was passed through 100-mesh and has been effective in controlling the insects.

In the last three years, considerable advance has been made in respect of the use of these dusts. Briscoe and co-workers[18] from the Imperial College of Science and investigators such as Parkin[19] from the Pest Infestation Laboratory, have tried to explain the various factors such as particle size, method of preparing the powders from different sources. The efficacy of a mineral dust may be correlated with the particle size secured from hard substances ground in the wet condition or in a micronizer, approaching that of colloidality and retaining simultaneously the microcrystalline or angular surfaces, which are lost by dry grinding. They have used the powder at 1 per cent. on the weight of the foodgrain but a lower percentage is possible. Less hard materials like gas-mask charcoal have also been successfully used in their studies.

As for raw materials, they select one with a hardness of over 6, on the Moh's scale, *i.e.*, harder than Pyrex glass. Carborundum is available in England and has been widely experimented with. It is costly. The cheapest material has been featured from power-house clinker fired by mechanical stokers. Feldspar is equally good. Silica in any form has to be discarded, being a source of silicosis. The search for cheap substitutes like paddy husk ash (?), has been successful, but it may not be quite well known that the scorched husk contains over 90 per cent. of the ash, as *free* silica. Railway clinker and similar materials had been tried by the writer successfully.

The most important factor in this project, is the size of particles of the powders used to coat the grains. The finer the particles, the greater is their adhesion to the grains and insects. It has been ascertained that a particle size above 20 μ does not stick to the grains. When the particles are about 1 μ, agglomeration of the same takes place, although adhesion is maximum. Such powders, when employed at 1 per cent. basis, give a very thick coating both on the grains and on insects. Chiu[16] correlated the action of crystalline silica against been weevils as follows:—

Diameter of particles in microns: Range	Diameter of particles in microns: Average	Days required to kill: 50%	Days required to kill: 100%
1—147	2·9	1·8	5·0
1—149	18·8	4·2	10·0
10–74	37·5	10·5	18·0
74–149	111·0	14·5	20·0

It may be pointed out here that particles above 20 μ are not considered effective. The maximum effect has been observed with a particle of 1·8–2 μ. In practice, particles ranging from below 15 μ are quite adequate for general use. In one of the trials, the distribution of particles in a carborundum powder has been reported as follows:—

under 1 μ	0·1%	between 5-7 μ	32·0%
1-3 μ	10·0%	7-9 μ	21·0%
3-5 μ	29·0%	Over 9 μ	8·0%

The distribution of particles in a given powder must be estimated by established methods such as those of Goodhouse.[20] But it must be cautioned here that "size classification by sedimentation in water is usually undesirable." The production of such fine powder is easily effected in commercial ball mills. The method of grinding influences largely the effect of the dust. While dry grinding may be quick and yield very fine powders, it had been ascertained that such powders had not the same effect as those ground wet. In grinding, the nature of the liquid is immaterial. This difference between dry and wet grinding is large in the case of clinkers, quartz, magnesite, etc. Where dry grinding has been effected, it was observed that treatment with hydrofluoric acid improved the effect of the dusts. Where the same could be secured in the precipitated condition, the activity was quite efficient. One of the most important aspects of the dusts treatment is that the powder intended for use must be kept dry, although it does not absorb water. The effect on the insect is one of desiccation without itself absorbing any water. Dusts differing greatly in chemical composition, but of similar composition show comparable effectiveness.

The influence of R.H. on the dusted grain is an important aspect. Thus at 100 per cent.

R.H. the mortality was hardly $1\frac{1}{2}$ times that of the control, while at 90 per cent. R.H., this activity rose to three times that of the controls. The work of Germar had already been referred to earlier.

In summarising the above, it may be mentioned that the process of coating grains with dusts is a simple one and consists merely in the mixing of the same with a definite quantity of the fine powder in a suitable equipment. This method can be used both for cereals and pulses. The general opinion in respect of eliminating the dusts, prior to milling, etc., is that it presents no difficulty. Moreover, many of the dusts are innocuous to the alimentary tract. The treated grain may be stored in closed containers so as to avoid exposure to atmosphere and to changes of weather. The coating of grains with dusts to control insects in stored products is, therefore, recommended for the following reasons. In the first place, it protects healthy grains from insect invasion. Secondly, the infested grains containing both the adults and larvæ are rapidly freed of these destructive agencies being desiccated and finally killed by the dusts. It may be mentioned here that the age of the insects is a factor, the young larvæ being more susceptible than the adults. The treatment is effective with regard to the existing population, in retarding oviposition and hence prevents reinfestation. The pupæ emerging from the eggs are rapidly killed by the dusts. Thirdly, the ray materials for these dusts are plentiful and the choice is very wide for selection for cheapness. None of them need be imported from abroad, as is the case with fumigants. The example of Egypt is worth emulating in this respect. The equipment for the production of such fine powders can be rigged up in each province, the same being very simple in character and construction. There is no harm introduced by these dusts, as is probable with fumigants. Finally, the process is economically practicable from the view-point of cost and ease of application.

The quality of the grain so treated is in no way affected. Only the treated grain does not flow as readily as the dry fresh grain, but this is no serious defect if it is remembered that the highly infested grain does not also flow readily.

A Practical Method for Treating Grains to Store Them

The following suggestions are thus made for practical adoption. The grain as received, is first sieved in a vibrating screen, whereby the adult insects are removed. Where the infestation is heavy, such grains may first be passed through a screw conveyor fixed in a jacketed galvanised iron trough, heated in a suitable manner. In this way, the dehydration of the grain is also effected. This is then screened. The clean grain is next mixed with the dust, which may vary from 0·3 to 1 per cent. on the weight of the grain depending upon the efficiency of the dust selected. The mixing may be done in drums, in various places, prior to storage in bins or granaries or other containers which may be capable of being closed fairly airtight. Such containers can also be of plaited bamboo, earthen structure, cement concrete and the like. These containers should be protected from destruction by rats. For this purpose, these are raised more than 3 feet high from the ground, standing on legs which are provided with 4-inch iron-sheets protruding outside alround the bottom.

The author had been interested recently in the processing of a cheap clinker and a non-siliceous material and could supply adequate quantities on demand.

1. Snow, D., *et al.*, *Ann Appl. Biol.*, 1944, **31**, 111. 2. Gane, R., *Chem. Ind.*, 1941, **60**, 44. 3. Barton Wright, E. C., and Tomkins, R. G., *Cereal Chem*, 1940, **17**, 332. 4. Snow, D., *et al.*, *Ann. appl. Biol.*, 1944, **31**, 102. 5. Germar, B., *Zt. angew. Ent.*, 1936, **22**, 603. 6. Neustead, R. d. Duvall, R. M., *Repts. of Grain Pests Committee, Royal Soc. Lond.*, 1918–20. 7. Oxley, T. A., and Howe, R. W., *Ann. Appl. Biol.*, 1944, **31**, 76. 8. Winteringham, *Chem. Ind.*, 1944 **63**. 9. Shafik, M. *Min. Agric. Egypt Tech. and Sci. Service Bull.*, 1938, **22**, 1–160. 10. Shepard, H. H., *et al.*, *Minnesota Agric. Expt. Sta. Bull.*, 1937, No. 120, 23. 11. Lindgren, D. L. and Shepard, H. H., *J. Econ. Ent.*, 1932, **25**, 248. 12. McCord, C. P., *Amer. J. Pub. Health*, 1934, **24**, 677-80. 13. Wirtschafter, Z. T., and Schwartz, E. D. *J. Soc. Hygiene and Toxicology*, 1939, **21**, 128–131. 14. Peters, G., *Sammlung Chem and Chem. Techni. Vortrage*, 1936, N.S., **31**, 120 pp. Stuttgart. 15. Zacher, F., *Mitt. Ges. Vorrat Schutz*, 1927, **3**, 30. 16. Chiu, S. F., *J. Econ. Ent.*, 1939, **32**, 240. 17. Narasimhan, M. J., and Krishnamurthi, B., *Current Science*, 1944. 18. Briscoe. H. V. A., *J. Roy. Soc. Arts*, 1943, **91**, 593. Kitchner, J. A., Alexander, P., and Briscoe, H. V. A., *Chem. Ind.*, 1943, **62**, 32–33. Alexander, P., Kitchner, J. A., Briscoe, H. V. A., *Ann. Appl. Biol.*, 1944, **31**, 143, 159. —, *Trans. Fard. Soc.*, 1944, **40**, 10. 19. Parkin, E. A., *Ann. Appl. Biol.*, 1944, **31**, 84. 20. Good-house, L. D., *J. Fcon. Ent.* 1938, **31**, 410.

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PITHECANTHROPUS IN PEKING

In reviewing the work of Weidenreich on *Sinanthropus*, Prof. W. E. Le Gros Clark seeks to establish that there is no justification for a separate genus *Sinanthropus* (*Antiquity*, XIX, 73). In this view, he is supported by Prof. Ruggles Gates who holds that *Sinanthropus pekinensis* should, according to the rules of biological nomenclature be called *Pithecanthropus pekinensis*. *Pithecanthropus* and *Sinanthropus* are related to each other in the same way as two different races of present mankind. The Java Man possessed essentially human palate and dentition and also quite human limbs and erect gait. From this probably arose the generalised Neanderthaloid type, which diverged in two directions, one of which led to the specialised European Neanderthal type of the later Mousterian date, and the second through Acheulean man to *Homo sapiens*.

LETTERS TO THE EDITOR

QUANTUM MECHANICAL THEORY OF THE JOSHI EFFECT

This phenomenon,[1,2] *viz.*, the suppression of conductivity on irradiation of chlorine and some other gases has been interpreted recently by Prasad[3] from the standpoint of Kramers' quantum mechanical theory of light dispersion. It is considered that consequent on irradiation the gas is excited to higher vibrational and electronic states. For these, due to the operation of negative terms in the Kramers' dispersion formula, the refractive index n decreases below that for the normal gas. Applying Maxwell's well-known relation, $n^2 = k$, where k is the dielectric constant, it follows that k should diminish. Since k is a measure of the electro-static capacity of the system, Prasad[3] considers that the light-effect as defined by Joshi,[2] represents a decrease of the displacement current as distinct from the conductance or ohmic current. Prasad[3] arrives at the same consequence from analogy between the excited and isolated states of a gas; for the latter k is known to be smaller than normal.

The validity of the above deduction was tested experimentally. Alternating electric fields of frequencies f veried in the range 5 to 10 mega-cycles per second, generated by a Hartley type valve oscillator were applied across the annular space of a Siemens' ozoniser, filled with pure chlorine. V, the P.D. across the ozoniser was measured by a thermionic valve voltmeter and the corresponding current with a *low resistance* Cambridge vacuo-junction connected to a sensitive mirror galvanometer. In an observation, typical of several series of results, at a given input to the system the current produced a steady deflection of 315 units. No detectable change ($>0\cdot5$ unit) occurred on irradiating the system with (*i*) a 500 candle power (glass) bulb, (*ii*) a large-size quartz mercury vapour lamp and (*iii*) when both the light sources were used simultaneously. A decrease of the above current which, according to Prasad,[3] is of the dielectric or displacement type, should have occurred, since ordinarily, this light-effect is quite considerable, and under optimum conditions as high as 93 per cent.[4]

Series of experiments were next made in which the discharge current in the above range were obtained by exciting the ozoniser at large V and low f. When, for example, the above current deflection was produced at $V = 10\cdot7$ kV, $f = 50$ cycles per second and the ozoniser was irradiated by any of the above-mentioned light-sources, an instantaneous and reversible *light-effect* in the range 19 to 27 per cent. was produced.

It would appear that as suggested by Prof. Joshi[2] an explanation of this phenomenon might, in the first instance, be sought, (*i*) in a possible decrease of the average ionic velocity and intensity of ionisation, (*ii*) increased recombination of the opposite ions and (*iii*) a decrease in the number of the

metastable (and excited) atoms and molecules, produced under irradiation. An important general result established by Prof. Joshi over a wide range of conditions, is that this phenomenon does not occur at potentials less than V_m,[1,5] 'the minimum threshold potential' when the gas breaks down as a dielectric.[5] In fact, it was from the observation by Prof. Joshi of a photo-increase of V_m[1] that (arguing from the finding that the current depends upon $V - V_m$[6]), he predicted that the corresponding current should decrease under light. Whatever be the actual mechanism of this phenomenon, it has significance for the current theories of photo-electric action and represents a hitherto unrecognised factor in conduction under electrical discharge.

Chemistry Department,
Benares Hindu University,
June 20, 1945.

G. S. Tiwari.
B. N. Prasad.

1. Joshi, (*a*) *Curr. Sci.*, 1939, **8**, 548; (*b*) *Ibid.*, 1944, **13**, 253; (*c*) *Ibid.*. 1945, **14**, 67. 2. —, *Pres. Address, Chem. Sec., Ind. Sci. Cong.* 1943. 3. Prasad, *Nature*, 1944, **155**, 362; *cf.* also Kroff, *Rev. Mod. Phys.*, 1932, **4**, 471; Ladenburg, *Ibid.*, 1833, **5**, 343. 4. Joshi and Deo, *Nature*, 1944 **153**, 434. 5. Joshi, *Ibid.*, 1944, **154**, 147. 6. Joshi, *Trans. Farad. Soc.*, 1929, **25**, 120.

THE BANDS OF PO MOLECULE

A vibrational quantum analysis of the bands of phosphorous monoxide in the region λ 2600 has been published by Ghosh and Ball[1] and a rotational analysis of some bands of this system has been given by Sen Gupta.[2] The bands are shown to be due to $^2\Sigma \rightarrow {}^2\pi$ transition. Besides this system, the PO molecule is well known to give rise to other characteristic groups of bands in the region λ 3300. The vibrational analysis of these bands does not appear to have been published so far. In the course of investigations, in this Laboratory, on the P_2 bands[3] excited under different conditions, the above-mentioned bands of the PO molecule have been obtained. These bands are found to be strongly emitted in a wide open heavy current arc between carbon poles containing phosphorous pentoxide. Some of the bands are degraded to the red and some to the violet. Several attempts to include all the bands into one system having failed, the red degraded bands are analysed into one vibrational system and the violet degraded bands into another system. The two systems have presumably a common final level 2π identical with the ground state of the ultraviolet system.

The following vibrational constants for the two systems are obtained.

Violet degraded system	Red degraded system
$\nu_e = 30606 \cdot 5$	$\nu_e = 30260 \cdot 8$
$\omega'_e = 1151 \cdot 9$	$\omega'_e = 1094$
$x'_e\omega'_e = 14 \cdot 19$	$x'_e\omega'_e = 14 \cdot 5$
$\omega_e'' = 1223 \cdot 9$	$\omega''_e = 1234$
$x''_e\omega_e'' = 6 \cdot 46$	$x''_e\omega''_e = 9 \cdot 5$

A detailed account of the work will be published elsewhere.

R. Ramanadham.
G. V. S. Ramachandra Rao.
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Guntur,
June 20, 1945.

1. Ghosh and Ball, *Zeits. f. Phy.*, 1931, **71**, 362. 2. Sen Gupta, *Proc. Phy. Soc.*, (Lond.), 1935, **47**, 247. 3. Narahari Rao, K., *Ind. Jour. Phy.*, 1943, **17**, 135 and 149.

ON THE ULTRA-VIOLET BANDS OF K

Besides the three systems of K_2 in the infra-red and visible regions studied by a number of workers, Yoshinaga[1] measured about 110 band heads in absorption between λ 4160 and λ 3480 A. and arranged them into five different systems, all arising on account of transitions from the $^1\Sigma_g$ ground state to different upper states. The only data at wave-lengths below λ 3480 A. are due to Chakraborty,[2] who noted some bands of K_2 accompanying each member of the principal series line of potassium. Since he worked with an instrument of high dispersion, only few bands could be recorded in his spectrogram.

While working with an Intermediate quartz spectrograph, a large number of bands, not reported earlier, between wave-lengths 3690 and 2920 A., has been noted in the present case. Of these, the bands between λ 3200 and λ 3100 A. are much better developed than those lying in the rest of the region. The experimental arrangement consists of an iron tube heated by an electric current flowing through a nichrome wire wound round an asbestos covering over the tube. The ends were closed by quartz windows and were water-cooled. Light from a hydrogen continuum was passed through potassium vapour obtained by heating a purified sample of the metal kept in an auxiliary iron cell inside the furnace tube and analysed by an Intermediate quartz spectrograph. Spectrograms were taken at several temperatures and pressures, the value of the latter being regulated by introducing dry nitrogn gas from a cylinder. The bands given in the table below (being more intense than those appearing in the rest of the region) were obtained at 700° C. when the pressure inside the furnace as read by a mercury manometer was 30 cm. The intensities were estimated from a micro-photogram of the spectrum.

ν cm.$^{-1}$ vac.	v″–v′	Int.	ν cm.$^{-1}$ vac.	v″–v′	Int.
31115	10–4	2	31467	5–2	1
31163	10–5	4	31517	5–3	2
31212	9–4	4	31557	4–2	2
31251	8–3	4	31606	4–3	2
31290	7–2	2	31679	2–1	1
31339	7–3	2	31726	1–0	1
31388	7–4	4	31818	0–0	1
31428	6–3	1	31868	0–1	1

The above bands can be represented by
$$31818 + 51v' - \cdot 5v'^2 - 92v'' + \cdot 3v''^2.$$
The agreement between the values of w_0'' and $x_0'' w_0''$ with those given by others is reasonably good.

Further work is in progress to classify the bands at wave-lengths both higher and lower than those given in the above table.

My thanks are due to Prof. D. K. Bhattacharya and to Prof. S. P. Prasad for their kind help and encouragement in doing this work.

Physics Laboratory,
Science College, S. P. SINHA.
Patna,
June 23, 1945.

1. *Phys. Math. Soc. Proc. Japan*, 1932, **19**, 847.
2. *Indian J. Phys.*, 936, **10**, 155.

A POSSIBLE "TERRESTRIAL EFFECT" IN THE ATMOSPHERIC OXYGEN SPECTRUM

IN a previous communication to this *Journal*[1] the author pointed out that if we were to accept, generally, current theories of the origin of the earth's magnetism and electricity, and of the internal geophysical structure, then it must follow that there exists an exceedingly strong electric field at the surface of the earth's internal core, and a variable charge in the uppermost atmosphere, as a result of which the electric potential of the earth's surface was not a fixed quantity, but that it varied over a wide range of values. Further, we should have to consider the terrestrial electric field system as being made up of three distinct components (1) the electric field at the surface of the internal spherical core (whose radius is 3,500 km.) of the order of 6×10^8 volts per cm.[2]; (2) the intermediate electric field within the crust or shell of thickness 2,900 km. indicated by the entrance at the under-surface of the crust of thermoelectrons and negative ions, and by the exit at the upper surface of air-earth current electrons and negative ions; and (3) the electric field at the earth's surface which owed its existence and magnitude also to the variable charge in the upper atmosphere.

Since the three are causally interdependent and spherically concentric, it must follow that the field as registered by an electrograph at the earth's surface must represent in magnitude, the resultant arising from all the three components, and we should be justified in representing the combined system for simplicity, as having a magnitude of 6×10^8 volts per cm. (or about 10^{11} volts per metre) at the core's surface, a value of 10^2 volts per metre at the earth's surface, and a negligibly small value at the lowermost levels of the upper atmosphere. The following relationship will be found to satisfy these values:
$$y = 10^{11} e^{-\cdot 0075\, x}$$
where y is the strength in volts per metre at any point in the composite field system at a height of x km. from the core's surface[3]; and integrating the expression between the values $x = 0$ and $x = 2{,}900$ km. (thickness of the crust), would now give us an approximate measure of the electric potential of the earth's surface with respect to the core, on a basis of 100 volts per metre as the recorded atmospheric field. It is of the order of 10^{13} volts. Should the atmospheric field be doubled or quadrupled, as it does in its usual course for example, the combined electric field throughout would be doubled or quadrupled, as also the potential of the earth's surface by a factor of 10^{13} volts. In other words, for every 100 volts per metre change in the recorded field, the electric potential energy of the earth's surface and of every molecule on it, would undergo a change of 10^{13} volts. And this would be identical with the action of an equivalent, hypothetical, applied, uniform, electric field at the earth's surface of the order of 10^{13} divided by 10^9 cm. (radius of the earth), or 10^4 volts per cm. acting on the molecule.

It would be interesting to investigate the possible spectroscopic implications of such an effect on molecules at the earth's surface. Changes in the potential energy of a molecule brought about by a strong applied, uniform, electric field are accompanied, in the main,[4] by a proportional shift in the position of the band lines, and a corresponding change in spectral intensity. It is, hence, significant that Perot[5] detected a diurnal change in wave-lengths in the A band of atmospheric oxygen which he did not account for adequately but which, on examination, will be found to coincide with diurnal changes in the magnitude of the universal component of the earth's electric field, namely, a secondary maximum of field strength at dawn corresponding to a maximum spectral frequency, a primary minimum around mid-day, and a primary maximum towards midnight. There is also a secondary minimum in field strength at about 4 a.m. by Indian standard time. In regard to intensity, the author found, particularly in the region of the atmospheric spectrum in which the oxygen bands predominate (the red), that intensity variations followed remarkably closely on changes in the atmospheric potential gradient at night,[6] and that these could not possibly be attributed either to atmospheric pollution or to any possible changes in the night sky light which was used as a background source in the course of the observations. Action by an electric field on the oxygen molecule is thus strongly suggested.

While quantitative work on verification of these findings is, at present, unfortunately held up for want of suitable equipment, it is important to note for the guidance of other workers, that the use of the solar spectrum and the usual interferometric methods[7] are liable to offset the effect under certain conditions, and that the most suitable means would seem to be the use, on a *clear* night, of a powerful source of artificial light, with an air path of several kilometers, for it is during the night that the earth's electric field undergoes its most striking changes. A series of half-hourly exposures during the same night should be recorded on one photographic plate, and corresponding changes in intensity and spectral location noted carefully.

I wish to thank Prof. N. R. Tawde of the Royal Institute of Science, Bombay, for many valuable suggestions during these investigations.

Colaba Observatory,
Bombay, ALFRED B. ARLICK.
June 30, 1945.

1. Arlick, A. B., *Curr. Sci.*, 1945, **14**, 151. 2. *Cf.* Prof. W. F. G. Swann's concise mathematical treatise "Terrestrial Magnetism: Theories of Permanent Magnetisation," *Encycl. Brit.*, 1943, **21**, 965 3. In reality the dielectric constant of the field medium traversed would have to be taken into consideration but, as we shall be dealing only with *relative* change, this omission need not mar the conclusions arrived at. 4. MacDonald, J. K. L., *Proc. Roy. Soc.*, 1932, **138**, 183-**202**. See also the other relevant references noted in that paper. 5. Perot, A., *Comptes Rendus*, 1915, **160**, 549. 6. Arlick, A. B., *Science and Culture*, 1939, **5**, 62. 7. Babcock, H. D., and John, S., *Astrophys J.*, 1922, **55**, 46. In a subsequent paper Babcock maintains that with a spectrograph of high resolving power, only 3 metres of air path need suffice.

ON THE ANALOGY BETWEEN THE POSITIVE LICHTENBERG FIGURE AND THE SPLASH OF A DROP OF LIQUID

AN interesting article by John Zeleny on the variation of the size and charge of positive Lichtenberg figures with voltage has appeared in the April 1945 issue of the *American Journal of Physics*. The present writer was much impressed by the similarity of the curves obtained by Zeleny showing the variations of the diameter of the positive Lichtenberg figures with charge and voltage, to the curves obtained by the writer showing the variations of the diameter of the splashes produced by drops of liquids of various masses and falling through various heights.

The curves showing the variation of the diameter of the Lichtenberg figure with voltage is again similar to the corresponding curve obtained by the writer showing the variation of the diameter of the splash produced by a drop of water of definite mass falling through various heights. In the latter case, however, the water drop attains a terminal velocity after falling through a certain height and the diameter of the splash remains constant after this height of fall.

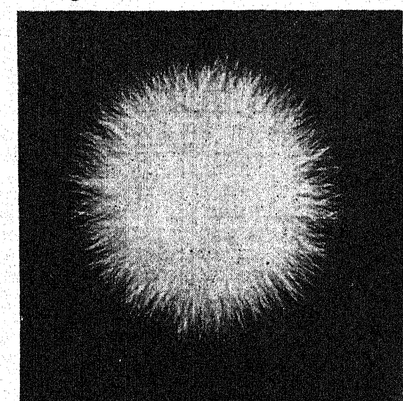


FIG. I (*a*)
Positive Lichtenberg Figure

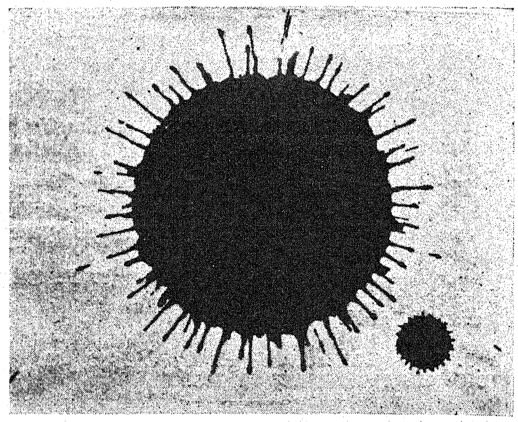


FIG. I (*b*)
Splash of a drop

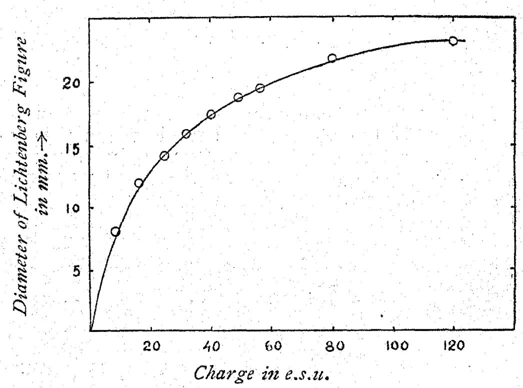


FIG. II (*a*)

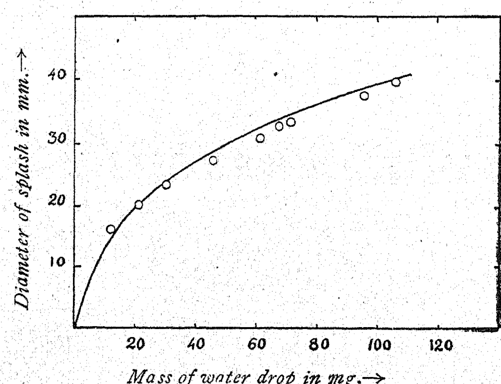


FIG. II (*b*)

This close similarity is no doubt due to the essential dynamical similarity of the two processes. The charge of the Lichtenberg figure corresponds to the mass of the liquid drop and the voltage corresponds to the height of fall of the liquid drop. Both processes are almost instantaneous. The Lichtenberg figure may, therefore, be regarded as a splash produced by a drop of electricity.

The Lichtenberg figure is obtained only on insulators like glass, ebonite, etc. On a good conductor the electricity immediately spreads. However, for different substances the diameters of the Lichtenberg figures are different.

In the corresponding case of the splash of the liquid drop, the diameter of the splash varies with the absorbing properties of the material on which it is produced. If any absorbent paper like filter-paper is used, the diameter of the splash is increased. This suggests that a good conductor acts like an infinite absorber of the electric charge and produces as it were a Lichtenberg figure having the size and shape of the conductor itself.

The analogy cannot obviously be pushed too far, but as far as it goes, it is interesting enough.

Department of Physics,
Nowrosjee Wadia College,
Poona, V. N. Kelkar.
August 10, 1945.

PARACHORS AND MOLECULAR DIMENSIONS

An equation to calculate molecular diameters in the liquid state from parachors has been already proposed by the author.[1] In the case of gaseous substances, molecular dimensions can be calculated by correlating the Van der Waals constant $b=\frac{V_c}{3}$ with parachor in the following manner. According to Sugden,[2] the mean value of $\frac{[P]}{V_c}=0\cdot 77$, where [P] and V_c are the parachor and critical volume respectively. Hence we get $b=\frac{[P]}{2\cdot 31}$. If molecules are assumed to be spherical in shape and if a substance is regarded as an assemblage of spheres of diameter σ packed together as closely as possible,[3] it has been calculated that $b=\frac{2}{3}\pi\sigma^3 N$, where N is the Avogadro constant. Thus,

$$\sigma=0\cdot 7\ [P]^{\frac{1}{3}}\times 10^{-8}\text{ cm.} \qquad \text{(i)}$$

The reliability of the ratio $\frac{[P]}{V_c}=0\cdot 77$ has now been determined by Herzog[4] to be of the order of $\pm$ 30%. Allowing a maximum deviation of $\pm$ 30% for this ratio, the reliability for σ will be of the order of $\pm$ 10%, since the above equation for calculating σ from [P] involves a cube-root of [P]. Calculations of molecular dimensions from parachors can be of great use in the study of chemical kinetics of reactions, since parachor data are more readily available than other data required to calculate molecular diameters.

If more reliable calculations are desired, the following method may be adopted. A dimensional analysis of the parachor gives the equation[5] $[P]=KV_c^{5/6}\ T_c^{1/4}$, the value of $K = 0\cdot 41$ being proposed by Ferguson.[6] Rewriting,

$$V_c=2\cdot 92\,\frac{[P]^{1\cdot 2}}{T_c^{0\cdot 3}}.$$

Substituting for V_c by 3b and for b as in (i), we get

$$2\pi\sigma^3 N=2\cdot 92\,\frac{[P]^{1\cdot 2}}{T_c^{0\cdot 3}}.$$

Hence

$$\sigma=0\cdot 92\,\frac{[P]^{0\cdot 4}}{T_c^{0\cdot 1}}\times 10^{-8}\text{ cm.} \qquad \text{(ii)}$$

Equation (ii) has a reliability of about $\pm 2\cdot 2\%$ for all compounds excepting the following:—those having the functional groups $-\mathrm{C}=0$, $-\mathrm{C}\equiv\mathrm{N}$, $-$ COOH, and $-$ OH, and one to three additional non-functional carbons.[4] For such substances, the following equation

$$\sigma=0\cdot 96\,\frac{[P]^{0\cdot 4}}{T_c^{0\cdot 1}}\times 10^{-8}\text{ cm.}$$

holds good with a reliability of $\pm 3\cdot 5\%$.

Laxminarayan Institute of Technology,
Nagpur University,
Nagpur, M. S. Telang.
May 15, 1945.

1. Telang, *Curr. Sci.*, 1943, **12**, 19–20. 2. Sugden, *J. Chem. Soc.*, 1924, **125**, 1177; "Parachor and Valency," Routledge, London, 1930, p. 31. 3. Jeans, "The Dynamical Theory of Gases," Cambridge University Press, 1925, p. 127. 4. Herzog, *Ind. Eng. Chem.*, [Ind. Ed.], 1944, **36**, 998. 5. Reilly and Rae, "Physico-Chemical Methods," 3rd ed., **1**., Methuen & Co., London, 1940, p. 110 6. Ferguson, *Nature*, 1930, **125**, 597.

POSITIVELY CHARGED FERRIC VANADATE SOL

In a communication[1] from this laboratory, the preparation of negatively charged ferric vanadate sol was described. It is now observed in presence of glucose ferric chloride dissolves a considerable amount of ammonium vanadate, to give a red coloured sol which bears a positive charge. The sol under investigation was prepared by dissolving 40 c.c. of ammonium vanadate solution (corresponding to 6·49 gms. of V_2O_5 per litre). In 20 c.c. of ferric chloride solution (corresponding to 34·92 gms. of Fe_2O_3 per litre) in presence of 20 c.c. of 20 per cent. glucose solution. The sol. was kept in a parchment paper and was dialysed for two days.

Composition of the Sol.—The amount of iron and vanadium in a known volume of the sol were determined by the standard methods of analysis. The combined iron corresponding to this amount of vanadium was calculated on the assumption that the ferric vanadate is $FeVO_4$. The rest of the iron is present as hydrated ferric oxide. From the ratio of the free to the combined iron, the emperical formula of the sol can be suggested.

Per litre:
Total iron—5·5282 gms.
Combined vanadium (V_2O_5)—3·1832 gms.
Combined iron—1·9540 gms.
Free iron—3·5742 gms.
Viscosity of the sol (30° C.)—0·00864 gms.
Viscosity of water (30° C.)—0·00803 gms.
Water bound—0·3519 gms.
Empirical formula—9 $Fe_2O_3 . 10\ FeVO_4 . 6H_2O$.

The amount of bound water per litre of the sol was calculated from the Hatschek's[2] equation expressed in the following form:

$$\text{Bound water per litre} = \frac{1000}{A} = 1000\left(\frac{\eta_t - \eta_w}{\eta_t}\right)^3$$

where A is the ratio of the total volume of water in the sol to the volume of the water bound, η_w is the viscosity of the water at 30°C. and η_t is the viscosity of the sol at the same temperature (*cf.* Prakash).[3]

Detailed procedure of the study of the sol will be published elsewhere.

I am indebted to Dr. Satya Prakash for his valuable guidance and advice.

Chemical Laboratories,
Allahabad University, S. P. MUSHRAN.
July 4, 1945.

1. Mushran, *Current Science*, 1945, **14**, 123. 2. Hatschek, *Kolloid. Z.*, 1911, **8**, 34. 3. Prakash, *Ibid.*, 1932, **60**, 184.

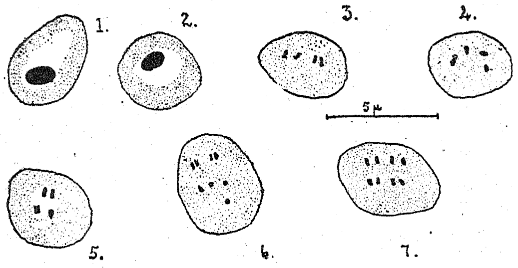
INDUCTION OF POLYPLOIDY IN *SACCHAROMYCES CEREVISIAE*

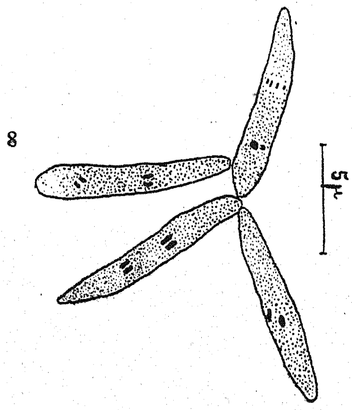
BAUCH[1,2] claims the production of new races of yeast by treatment with camphor and acenaphthene. Since these new races were bigger than the original strains he tentatively suggests that the chromosome numbers ought to have been doubled, tripled or quadrupled. However, no cytological confirmation seems to have been attempted. Since this line of attack offered interesting possibilities some experiments were conducted in this direction.

Sterile test-tubes of wort were inoculated with a loopful of Sc 9 (N.C.T.C. 3007) from a wort-agar slant and a few cyrstals of acenaphthene were added to the tubes. The time of treatment was arbitrarily fixed at 6 hours in order to have sufficient material for smearing. At the end of the above period the material in the tube was centrifuged and smears were made at definite intervals to get the mitotic figures. The slides were fixed in Carnoy and stained in Heidenhain's hæmatoxylin.

The pictures obtained were very interesting. Long thread-like mycelial growths are common, the cells measuring 9-10 μ in length and 1·5-2·0 μ in width (Fig. 8). Resting cells vary in dimensions from 3·5 μ to 5·5 μ and have a clear cytoplasm having a large vacuole and a stained nucleus (Figs. 1 and 2).

What strikes one is the large number of cells having four chromosomes disposed in various ways (Figs. 3, 4 and 5). Cells showing eight such chromosome-like structures are also common (Figs. 6 and 7). The measurements of the chromosomes are not given since the equipment at my disposal does not enable accurate measurements to be made. However, they appear to be far smaller than those





of the control strain (see Subramaniam and Ranganathan[3]). This disparity in the size of the chromosomes in different strains might have been the cause for the controversy concerning the identification of certain structures seen in the yeast cell during vegetative division, as the chromosomes (see Subramaniam and Ranganathan[4]).

What appears to be a tetraploid strain has been isolated by planting and this is now being purified. Uptill now all the cultures have been kept in the vegetative condition. Whether these strains would retain their chromosome constitution after repeated sporulation and whether they have any economic importance can only be judged after extensive tests.

I am very grateful to Sir J. C. Ghosh and Sri. M. Sreenivasaya for their active interest and encouragement, and to Messrs. The K. C. P., Ltd., Uyyuru, for the award of a Studentship.

Fermentation Technology Section,
Indian Institute of Science,
Bangalore, M. K. SUBRAMANIAM.
June 1, 1945.

1. Bauch, R., *Naturwissenschaften*, 1941, **29**, 503-504. 2. —, *Woch Brau*, 1941, **59**, 1-7; 9-11. 3. Subramaniam, M. K., and Ranganathan, B., *Curr. Sci.*, 1945, **14**, 78-79. 4. —, *Ibid.*, 1945, **14**, 131-132.

A NOTE ON THE ASSOCIATION OF *CHLOROCOCCUM HUMICOLUM* IN THE ROOTS OF *CYCAS REVOLUTA*

DURING the course of their investigations on the microbial flora associated with the nodules and root-forms of some non-leguminous plants, the work on *Cycas revoluta* was planned with a view to ascertain the synergetic action of all the biological entities present within the roots. Special attention was paid to the study of the well-known *Anabœna cycadœ*, an alga of ecological interest. For isolating this alga various media, including Beijerinck's basal ammonium nitrate solution, Benecke's solution and a new medium (nitrogen-free) devised by the authors, were tried.

It was observed that the coral roots of one of the many *Cycas revoluta* plants they had examined consistently gave rise, in the new medium referred to above, to a new type of algal growth (which on examination for morphological features proved to be *Chlorococcus humicolum*) not hitherto recorded. It was also observed that the preliminary growth of this alga (which is presumably new for the roots of Cycas) appeared only after about three months of incubation at the room temperature (about 27° C.), whereas the sub-cultures of the same made evident its growth in the same medium within a brief period of fifteen days. It must also be mentioned in this connection that the algal growth was absolutely free from any other growth, microbial or otherwise.

The medium above referred to had the following composition:—

Water (distilled)—1,000 c.c.
Di-potassium-hydrogen
phosphate—0·20 gm.
Potassium chloride—0·10 gm.
Calcium carbonate—0·10 gm.
Ferric chloride—0·10 gm.

A glance at the ingredients will at once reveal that it is a purely synthetic medium, and what is more striking, is that it contained no nitrogen in either organic or inorganic form.

As far as the present authors are aware, *Chlorococcum humicolum* has not been recorded to occur as an endophytic organism in the corolloid roots of Cycas, though it is a widely distributed algal species, occurring in a diversity of habitat such as damp soil, brick-work, etc.

This alga grows luxuriantly in both Beijerinck's and Benecke's media, yet the fact that satisfactory growth of the alga takes place in the nitrogen-free medium also, suggests that the alga can tolerate an absence of combined nitrogen and leads to the presumption that it is a nitrogen fixer. Its presence together with various other biological entities associated in the roots of Cycas points to the role of these organisms in the nitrogen metabolism of the plants in whose roots they occur. And the recent observations of Yoshimura amply support such a view.

The authors wish to thank (Mrs.) E. Gonsalves, of the Royal Institute of Science, for kindly verifying the identity of the new alga isolated.

Microbiology Department,
St. Xavier's College,
Bombay,
June 1945.

F. FERNANDES.
J. V. BHAT.

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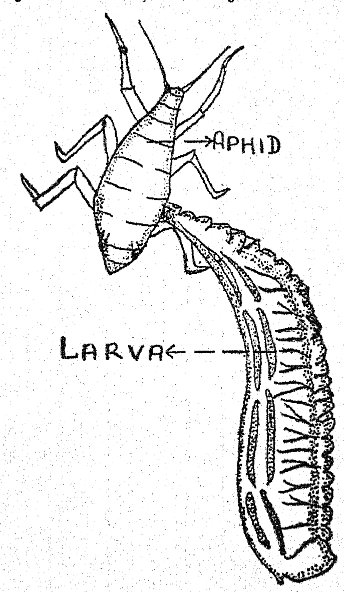
NOTES ON A SYRPHID (*SPHAEROPHORIA SCUTELLARIS* FAB.) FLY PREDATOR ON MUSTARD-APHID (*RHOPALOSIPHUM PSEUDOBRASSICAE* DAVIS)

DURING the course of my study of biology of the mustard-aphid, *Rhopalosiphum pseudobrassicœ*, syrphid-fly larvæ were observed among the aphids. It was rare to find any colony of the aphids that did not have from one to many elongate larvæ preying upon them. Hidden among the aphids, these larvæ (Fig. 1) grasp aphid after aphid by their pointed jaws, raise it in the air, slowly pick out and suck out all the body contents, finally discarding the



empty skin. It has been observed that sometimes a larva destroys aphids at the rate of one every minute and this process continues for a considerable period. In fact, the rate of

destruction depends on the age of both the larvæ and the aphid, *i.e.*, a full-developed larva can destroy larger number of aphids of younger ages. It has also been observed that the larva attacks not only apterous aphids but can attack and destroy even the winged aphids when they come within its reach. The predator appears to be of a very great importance, and, therefore, a short account of it is given here.

Egg.—The eggs are laid by the adult fly among the aphid-colony. The eggs are pearl-white and more or less elliptical in shape with gently rounded ends. The anterior end is somewhat flattened, it is the place where opening is formed at the time of hatching of the egg. The egg-surface is covered with longitudinal ridges which are connected with one another through transverse ridges and thus a number of quadrangular areas are formed all over the egg-surface. The egg is about 0·9 mm. long and about 0·4 mm. thick.

Larva.—The full-grown larva is slender, with the ventral aspect flattened and the body much attenuated anteriorly. The cuticle is tough and leathery and greenish or brownish. The segmentation is more or less obscure owing to the transverse corrugation of the body. However, a closer study shows that there are eleven segments. The general appearance is rather slug-like. The technical system is of amphipneustic type, *i.e.*, only the prothoracic and the posterior abdominal spiracles are open. The anterior spiracles are on the second apparent segment, while the posterior pair is situated on two tubes which are very short and are fused together down the median line. From the sucker-like mouth located on the undersurface of the first segment, protrudes a pair of black-toothed hooks —the mandibles. These are supported by and connected to the cephalopharyngeal skeleton, which is a V-shaped structure extending back into the body as far as about the third segment. The cephalopharyngeal skeleton is a blackish scleritised structure and is usually visible through the integument of the larva. It differs in shape in different larval stages. In the first larval stage it is small and incompletely developed, while in the last larval stage it is completely developed and the parts are easily distinguishable. The full-grown larva is about 9 mm. long and about 2·5 mm. at the thickest place.

Pupa.—Prior to pupation the larvæ come to rest near their habitat, the caudal segments become cemented to the leaf or to the cage-wall with a black secretion apparently exuded from the hind gut. The pupa becomes again cemented if it is decemented. This shows that the secretion restarts when required. The pupa forms inside the last larval skin. The puparium is inflated dorsally and laterally. Spiracles are present on the puparium in the region of the fourth segment and are elevated upon conspicuous horns. The pupa is about 1·5 mm. thick and about 6 mm. long. The anterior end is more or less cap-like while the posterior end is more or less flattened. The eclosion of the imago takes place by means of a transverse rupture of the puparium near the anterior end.

Adult.—In general, the male is distinguished from the female by its larger size, and the unequal facets of the contiguous compound eyes. *Head*: Face yellow; compound eyes, deep maroon having a golden hue, and separated from each other at vertex region by a distance of about 0·5 mm. Antennæ are brown or black dorsally and orange ventrally. Arista brown or blackish. Proboscis dark brown. *Thorax* deep blue with a narrow streak at the sides. Scutellum yellow with a smoky pubescence. *Abdomen* shining black dorsally with a pair of yellow spots on the second segment and a yellow band on each of the third, fourth and fifth segments; the band on the fifth segment is thinner than the bands on the third and fourth segments which are more or less equally thick. Distal margin each of the third and the fourth segments has a thin brown border and that of the fifth segment a thick brown one. *Legs* are brownish yellow with their coxæ and trochanters slaty coloured and with their tarsals blackish.

The life-cycle is completed within 15 to 20 days. The incubation period is 3 to 4 days, larval period 7 to 9 days and the pupal period 5 to 6 days.

My thanks are due to N. M. Deshmukh, Esq., Director of Agriculture, Gwalior Government, for helpful encouragement, and to Mr. K. N. Pawar, Chief Chemist, for going through the MSS.

A detailed account will be published elsewhere showing its importance in biological control. The work is in progress.

Agricultural Research Labs.,
Gwalior,
April 10, 1945.
R. Rakshpal.

POTATO SPROUTS AS A SOURCE OF "SEED"

In the past various workers have attempted to devise ways of propagating the potato plant by such methods as would reduce the seed rate. The usual method is to plant either the whole or a part of the seed tuber. This asexual mode of propagation is now the universally-employed method of planting potatoes. The only other method so far known is to raise the plants from the true seed. The potato plant being heterozygous yields a variety of new types when either selfed or crossed seed, obtained from the berries, is sown. It is apparent that by this method it is neither possible to maintain a type nor is it profitable to raise a commercial crop, and its usefulness is, therefore, limited to scientific investigations and for the breeding of new varieties.

Seed tubers may be planted whole or as cut-seed-pieces and it has been determined that a seed piece weighing about two ounces is the most desirable size to plant. Thus, for every plant about two-ounce weight of seed tuber is required as an initial start. This high seed rate has come in the way of expansion of potato cultivation, particularly due to transport and other difficulties created by the war. Scientists have, therefore, been busy in

devising ways and means of overcoming these problems. In Russia Lysenko and his associates[1] reduced the weight of seed required per acre by utilization of potato "tops", the remaining 90 per cent. or so of the tuber being used for food purposes. Similar methods of utilizing small portions of eyes called by various names as "chips", "peelings", etc., have been suggested by Copisarow[2] and Evans.[3] Evans has been able to transport potato 'tops' from one place to another by air and claims to have got satisfactory yields. The possibility of utilization and adoption in potato culture of the above and other similar methods has been recently investigated in this country by Pal and Deshmukh[4] and by Sen and Chakarvarti.[5] They have determined that thin pieces from eyes or "peelings" give in general a poorer crop than that raised from the "tops". A suggestion has been offered that a closer spacing might compensate for the decreased yields which they obtained in comparison to the controls (raised from whole tubers).

The above review will show that all the workers have hitherto agreed that detachment of the eyes with either a small or a large piece of the flesh is necessary to raise a potato plant. After the eyes have been sliced off the tuber it serves no further use except in the kitchen. Viewed from another aspect it would mean that a seed tuber, say with ten eyes, has a possibility of giving rise to ten plants at the most, and even this is not practicable as invariably three or four eyes are crowded towards the rose end of the tuber and these when removed serve as one seed-piece.

For the last ten years the Potato Breeding Station at Simla has been engaged on the breeding of better types of potatoes, and it has been necessary to multiply the new varieties rapidly from the original seedling plant. Multiplication of seed, even for a small-scale trial, takes several years. The writer has been therefore, in search of a method by which a tuber could be made to give rise to a very large number of plants, and through persistent efforts has developed a method of tuberless sowing of potatoes which promises to be of value not only for scientific workers engaged in potato investigation but also for potato production, in certain areas.

This new method consists of raising the crop from the sprouts without damaging the eyes. The sprouts when they are about 1 to 2 inches in height are detached from the tuber and suitably planted in beds. Within about a week's time the sprouts develop roots, especially at the basal nodes and within two to three weeks' time the sprouts develop a crown of leaves and at this stage they can be transplanted. The "Sproutlings" are very hardy and except for watering, during the first week or so after transplanting, do not require any other special treatment; in fact, they are as easy to handle as chilli or brinjal seedlings.

Several methods of inducing rapid rooting of sprouts were investigated. Among these pretreatment of sprouts with hormotone was tried out but this did not show ony beneficial results. As the sprouts can be made root readily in soil, where as much as 100 per cent. success has been obtained, no pretreatment of the sprouts seems to be necessary. It may be of interest to mention here that it has also been possible to get plants from sprout cuttings. Some varieties during storage produce very long sprouts and it has been a general practice to detach and throw away all such sprouts before planting of tubers. A long sprout can, however, give rise to three or four sproutlings if suitably treated. The details of the method of obtaining sproutlings are being published shortly.

The use of sprouts as seed is already proving very helpful in rapidly building up the stocks of the new potato varieties at the Simla Potato Breeding Station. There is every reason to believe that satisfactory yields can be obtained through the use of sproutlings. Experiments are in progress at Simla where ways and means of utilization of this method on a commercial scale are being investigated and the results of these findings will be published as the work progresses. In the meantime announcement of this method has been made as this may prove to be of much value, at least in some parts of this country, in the solution of some of the problems connected with the seed potato industry. Each seed tuber is capable of producing a very large number of sprouts. A four-ounce seed tuber would under normal circumstances yield two to four seed pieces, while a tuber of similar size, having about ten eyes, can be made to yield 20-40 good sprouts and the mother-tuber can still be utilized for seed purposes at the end. This is possible because a large number of sprouts develop after the first crop of sprouts has been removed and a tuber is capable of producing two to four such crops. Packets of sprouts have been successfully sent by post, and have rooted well when planted out.

As sprouts do not carry any part of the flesh or the skin, their use as seed reduces the possibility of transmission of tuber-borne fungal or bacterial diseases from the tuber to the soil. Again the tuber often does not show any visible signs of virus infection and it is not, therefore, possible to eliminate the virus-infected ones before the sets are planted out in the field. On the other hand, the 'sproutlings' being transplanted after the first crown of leaves have appeared makes it possible to select only such 'sproutlings' as are apparently free from virus infection. A higher standard of health can thus be expected. The adoption of sproutling method in any scheme of scientific seed-production will thus be of value.

Potato Breeding Station,
Simla, PUSHKARNATH.
April 27, 1944.

* Financed by the Imperial Council of Agricultural Research.

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PHYLLODY OF TIL IN RELATION TO DATE OF SOWING

PHYLLODY, also known as 'Sepaloidy', or 'Green flower' disease, is known to occur in the sesamum crop in various parts of India and Burma. Storey[1] has attributed it to the disturbed physiological conditions induced by the early sowings and heavy rainfall, while Pal[2] suggested that it might possibly be due to a virus. Til (*Sesamum orientale* L.), an important *kharif* season oil-seed crop in Sind, has suffered severely as a result of incidence of this disease. The area under this crop in Sind has decreased from about 42,000 acres in 1934-35 to about 6,000 acres in 1940-41.

In our breeding work, to evolve a high yielding, disease-free type of *til*, a black-seeded variety, *Jamesabad*-33, has been found to be promising. In order to test the variety and also to determine the optimum period of sowing, a factorial design experiment was conducted for two years with four sowing dates (mid-July, end-July, mid-August and end-August) and two varieties, *viz.*, *Jamesabad*-33 (black-seeded) and *Cawnpore s*-6 (white-seeded). During the second year (1943-44) the experiment was repeated with a slight modification, *i.e.*, another promising variety, *Karho Johi*, was added. During the first year there was a combined attack of the caterpillar (*Antigastra catalaunalis*) and phyllody. The year 1943-44 was characterised by the absence of the caterpillar but there was a severe occurrence of phyllody. This gave an opportunity of gauging the effect of various sowing dates on the occurrence of phyllody. The percentage of its occurrence was recorded in the various sowings and was statistically analysed. The results obtained would be of great interest to other workers in this direction. The data regarding the infection are presented in the following table:—

TABLE I

Percentage of Phyllody during 1943-44

Variety / Sowing	Jamesa-bad-33	Cawnpore s-6	Karho Johi	Average of sowing	Conclusion
Mid-July (12th July '43)	11·09	22·7	13·20	15·67	Significant at P = 0·01
End-July (27th July '43)	5·66	8·04	6·44	6·71	
Mid-August (12th August' 43)	0·77	0·82	0·78	0·89	Significance difference = 3·161
End-August (27th August' 43)	0·93	2·89	0·60	1·47	

The yield data of the different varieties in the different sowings for two years are tabulated in Table II.

The data presented in Table I clearly indicate that there was a significantly higher attack of phyllody in all the varieties in the mid-July sowing, which continued to decrease till mid-August, after which no significant decrease

TABLE II

Yields of the Different Varieties for different Sowings

Year	Mean yield in lb. per acre				
	1942–43		1943–44		
Variety / Sowing	Jamesabad 33	Cawnpore s–6	Jamesabad 33	Cawnpore s–6	Karho Johi
Mid-July	568	213	544	254	378
End July	579	363	562	412	542
Mid-August	621	326	604	464	519
End August	513	187	138	22	102

was observed. Correlating the yields of the various sowings with those of infection percentage, it is seen that there is a corresponding increase in the yield in the mid-August sowings. In the last sowing, though the occurrence of phyllody was less, yet the yield was low, due to diminished vegetative growth. Therefore early sowings appear definitely conducive to the occurrence of the disease. Another fact which is evident from the above is that certain varieties possess considerable resistance to phyllody. Thus the improved black-seeded variety, *Jamesabad*-33, is affected the least while the white-seeded variety, *Cawnpore-s*-6, is significantly more affected. In yield also the variety, *Jamesabad*-33, has given significantly higher yields than the others.

I wish to express my thanks to Dr. T. J. Mirchandani, Officer-in-charge, Agricultural Research Station, Dokri, for valuable suggestions and criticism.

Agricultural Research Station,
Dokri, Sind, M. V. VACHHANI.
May 4, 1945.

1. Storey, H. H., *Rept. East African Agric. Res. Stn. Amani*, 1932–33, p. 16 2. Pal, B. P., *et al.*, *J. Agric. Sci.*, 1935, **5**, 517.

SOME ABNORMALITIES IN COTTON GROWN UNDER CONSTANT LEVELS IN POTS

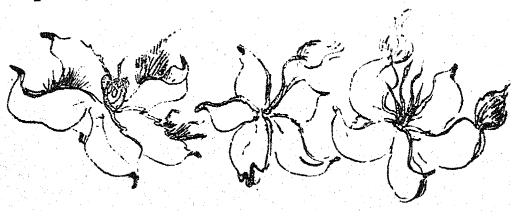
Two strains of cotton, one *desi* (*G. arboreum* race *bengalense*), strain No. 43, and the other, American (*G. hirsutum*), M.U. 4, were grown in pots with three different constant levels of moisture mainly to study the transpiration of the plants. In the course of the periodical examination of the plants it was found that there were several abnormalities met with and some of the more important ones are recorded here. Such abnormalities were, however, not noticed in the plants of the same varieties grown as a field-crop under normal conditions. It cannot be said whether the abnormal condition of growing the plant in pots that is responsible for these aberrations. The different

moisture levels maintained in the pots had also nothing to do with most of the freaks, inasmuch as, the abnormality concerned was observed not at any particular moisture level only but at all levels.

I. Boll Abnormalities

(*a*) In many of the American cotton bolls an extra erect body resembling very much the gynaceum of the cotton plant with green ovary and dark nigropunctate glands were found in the centre when the bolls dehisced. In a few instances the three- or four-carpelled ovaries of this appendage exhibited minute fuzzy ovules inside them (Fig. *a*).

(*b*) The cotton fibre usually develops on the cotton seed; but a few lint hairs were found to develop both in the American and *desi* varieties from the carpel wall, suture and the ridges of the locules. Again, in American, a tuft of fibres was given out by the apex of the extra gynaceous body as well as the apex of the carpel (Figs. *a*, *b* and *c*).



a *b* *c*

(*c*) In a few Asiatic plants, bolls having three-carpels and in addition a partially developed carpel were recorded.

II. Leaf and Flower Abnormalities

Besides the above abnormality, there were found certain abnormalities with regard to leaf and flowers which are mentioned below:—

(*a*) In the *Desi* cotton grown under higher levels of moisture three leaves having double lamina (mirror image) with a twin petiole joint right through, developed. Another plant under low moisture, put forth two consecutive leaves, the lower leaf having only the right half of the lamina of a normal leaf while the upper developed the left half. The petioles of these leaves were reduced in thickness.

(*b*) A plant grown under low level of moisture produced a flower with two bracts while two plants grown under the highest level of moisture produced flowers having four to seven lanceolate bracts. In a plant grown under optimum condition, a double and a triple flower of different ages were produced on a single pedicel with three common bracts in addition to their own.

The abnormalities of leaves and flowers are not very important but the presence of lint on the carpel walls and lock sutures is very unusual and has not been recorded before. The material grown was from selfed seed of a single plant. While the cause for the boll abnormality is not known, the material has been carefully gathered and will be grown again both in pots and under ordinary conditions to see if the same will be repeated.

The work was carried out in the Cotton Genetics Research Scheme, Indore, financed by the Indian Central Cotton Committee.

Institute of Plant Industry,
Indore, C.I., P. S. Sreenivasan.
May 8, 1945.

LONG SMUT OF SORGHUM-METHOD OF INFECTION

Long-smut of Sorghum caused by *Tolyporium Ehrenbergii* (Kuhn) Pat., has been recorded from India and Africa. In India, it is known to occur in Baluchistan, Sind and Madras. It has been regarded to be not a very destructive disease as the smut attacks only a few grains in an earhead. But in recent years, a survey of the disease was undertaken in Sind, and it was found in the year 1943, that the smut was present practically in every earhead and the number of grains attacked varied from 1 to 30. In India, its presence has been recorded by Butler (1918) and Kulkarni (1918). Kamat (1933) has studied the cultural characters of the fungus and also the effect of temperature on the growth of the fungus in culture. So far no worker has attempted to establish the method of infection of this smut. Butler has suggested that the infection may be a localised one. To determine exactly how this disease appears, this investigation was undertaken.

Effort was made to produce the disease in a number of ways, (*i*) spores of the smut were mixed with seed before sowing, (*ii*) spores were mixed with soil, (*iii*) Moore's vacuum method of infection, (*iv*) spores were dusted on the flowers, (*v*) spores were germinated on potato-dextrose agar and sporidia were obtained in culture. A suspension of sporidia was made in water and a few drops of this suspension were placed in the buds with the help of a pipette.

It was observed that no infection appeared in the case of first four methods. Infection in the case of last method was very successful and ninety per cent. of the infected earheads bore smuted grains. It is quite clear from the above experiment that chlamydospores by themselves do not play any role in the production of the disease. It is the sporidia which take an active part. It is likely that the chlamydospores from the previous crop lie in the soil and the development of favourable conditions, germinate and produce sporidia. These sporidia in turn are carried by means of air to the earheads and produce the disease. Study is being made to confirm the above assumption and also of the factors which induce prolific production of sporidia.

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Agricultural Research Station,
Sakrand, N. Prasad.
May 23, 1945.

1. Butler, E. J., *Fungi and Disease in Plants*, 1918. Thacker, Spink & Co. 2. Kulkarni, G. S., "Smuts of jowar in Bombay Presidency," *Bulletin* No. 78, 1918. 3. Kamat, M. N., *Phytopath.*, 1933, **33**, No. 12, 985-992.

THE INDIAN FAUNA DURING 1943-44

Official statistics of the number of wild animals shot in the various provinces (except Madras) and in Kashmir and Jammu States during 1943-44 are given in the *Indian Forester*.[1] Of the animals that are in grave danger of becoming extinct but now safeguarded by Acts (*viz.*, the Bengal Rhinoceros Preservation Act, 1932, and the Elephant Preservation Act, 1879), only 3 rhinoceroses were killed in the whole of India (in Assam), and 33 wild elephants shot in the several provinces, Assam claiming the maximum (18).

Turning to carnivora, a total of 224 tigers and tigresses were shot, greater number in C.P. and Berar (73) and U.P. (69); of leopard or panther, 211 were shot, U.P. heading the list (50), and 37 each in C.P. and Berar and Bombay. Wild cats claim 91 (58 in Jammu and Kashmir). Of the bears shot, Himalayan black bear leads with 37 (30 in Jammu and Kashmir) and sloth bear 28. Of the deer tribe, the maximum number shot was *cheetal* or spotted deer 511 (Bengal responsible for 211, U.P. 57, C.P. and Berar 108), the number of sambar shot was 235 (95 in U.P. and 53 in C.P. and Berar). Of the 213 barking deer, Bengal is responsible for 120. Nine 4-horned antelopes were also shot.

Other interesting figures are Gaur or bison 38 (13 in Bombay), *nilgai* or blue-bull 212 (119 in Bombay), crocodile 16 (14 in U.P.), python 14 (6 each in Bengal and U.P.). Increase in the number of animals shot over last year's record is noted, in the case of leopard or panther 38; wild cats 76; *nilgai* 106; barking deer 54; *cheetal* or spotted deer 220. This increase in mortality in wild animals is perhaps due to the large increase in the fighting forces in India.

These figures refer to 'Reserve forests' only and are, therefore, no true reflection of the state of affairs. There is no machinery for the collection of figures of the numerous animals shot in the unclassified State forests, grants, grazing land, etc. There is also no record of mortality in the case of games and fishes.

Recently, it was reported in the press that 25 tigers were shot in one district in Assam outside Reserve during 1944, and there is no doubt that game animals and birds are rapidly disappearing in this country. The reason is indiscriminate slaughter of females and immature males in the open season and of both in the closed season, particularly deer and birds and unless Government takes timely action, India's marvellous fauna is doomed to extinction.

In 1935, the Government of India convened a conference of the representatives of all the Provinces and the States in India on the subject of the "Preservation of Wild Life", presided over by the late Mian Sir Fazl-i-Hussain. Since then, Dr. Baini Prashad, formerly Director, Zoological Survey of India, in his address to the Eighth Annual Meeting of the National Institute of Sciences of India in 1943, discussed at length the subject of "Conservation of Wild Life in India". Unfortunately their suggestions have not yet been given effect to. It is now for the relevant post-war reconstruction committee to chalk out a programme, based on the recommendations of these two valuable memoranda.

A wise policy of wild life conservation should provide for: (1) Adequate laws of protection, (2) adequate areas as permanent sanctuaries or refuges for species in their known habitat, (3) adequate organization to enforce the former and administer the latter.

An active unofficial "All-India Organization" for the protection of games, fishes, fauna and flora of India on the models of similar organizations in all progressive countries can also render useful service in this direction. In 1936, the United Provinces inaugurated under the distinguished patronage of Sir Malcolm Hailey (now Lord Hailey), an "Association for the Preservation of Games" in that province, and also started publishing a journal entitled *The Indian Wild Life*. Owing to the abnormal conditions resulting from the war, the activities of this society has received a setback. The United Provinces is also the pioneer in India in passing the "National Parks Act, 1934" that resulted in the conversion of "Hailey Park" to "National Park" with an area of 100 sq. miles. Will other Provinces and States lag behind? What we need most are "National Sanctuaries". The relevant post-war reconstruction committee should bear this in mind.

Botany Department,
Calcutta University, A. K. Ghosh.
June 11, 1945.

1. *Indian Forester*, March 1945, **71**, No. 3.

A PODOSTEMAD FROM THE EASTERN GHAT HILLS IN ORISSA

Members of the family Podostemonaceæ have been recorded from South India, Ceylon, Eastern Himalayas, Assam, Burma, etc. (*cf.* Hooker,[2] Willis[4]). Recently, Randhawa and Joshi[3] reported the occurrence of a podostemad from the Kumaon Hills, Central Himalayas. According to them, the plant collected by them is to be regarded as a new species of *Zeylanidium* Tul., a sub-genus of *Hydrobryum* Endl. (Willis).[4] Haines[1] previously recorded the occurrence of *Lawia zeylanica*, another member of the family Podostemonaceæ from Orissa. According to him, it occurs in patches on the wet rocks in the rivers of Angul (Cuttack District) in Orissa. He described the same in his *Flora of Bihar and Orissa*.[1] The occurrence of a Podostemad from another locality in Orissa is recorded here and is of interest in connection with the geographical distributon of the family.

The Podostemad collected by the writer has ribbon-like and branching thallus. It was found growing closely attached to wet stones occurring in the hill stream 'Putra gadh' flowing through shady forest in the 'Jolla Mundi' Valley near the village 'Mogal patta' (82° 30′: 18° 59′) situated about 4-5 miles north off Jeypore, Orissa. It was collected in the

flowering and fruiting stages in the month of January 1938 and was growing in association with a species of *Batrochospermum*. From a comparison of the specimens with characters of the other members of the family, it is found to belong to *Zeylanidium* Tul., which was described by Willis[4] as a sub-genus of *Hydrobryum* Endl. The plant here reported is identified as *Z. lichenoides*. The species has been previously recorded as occurring in Burma, Assam, Bombay Ghats to Travancore and Ceylon.

My thanks are due to Mr. K. C. Jacob (then of the Herbarium, Agricultural College, Coimbatore) for kindly confirming the identification of the species.

Andhra University,
Guntur, J. VENKATESWARLU.
June 30, 1945.

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EFFECT OF PHOTOPERIODIC TREATMENT ON POLLEN FERTILITY

OUT of the five postulated phases in the developmental process of a plant, two have been established with reasonable certainty. Recent evidence[1,2] gives some indications regarding the nature of two new developmental phases.

During the course of investigations on phasic development of wheat at this Institute, it has been observed that the formation of normally functioning gametes depended upon preliminary phasic changes in the cells of the gametophyte brought about by photoperiodic treatment. As the results appear to be of some academic and practical interest a brief preliminary report is made here.

Graded seeds of three varieties of wheat (*Triticum vulgare*), *viz.*, I.P. 165, I.P. 52 and P.C. 591, were germinated and kept for the first twelve days under the following five 'initial' light treatments:—

(1) Complete darkness; (2) six hours of natural light; (3) twelve hours of natural light; (4) same as No. (3) *plus* six hours of artificial light; (5) same as No. (3) *plus* twelve hours of artificial light (200 W. daylight lamp at a distance of 2 ft.).

At the end of this initial light treatment plans were exposed to three photoperiods, *viz.*, (*a*) short-day—6 hr. day; (*b*) normal-day—12 hr. day; and (*c*) long-day—18 hr. day upto the time of anthesis.

Pollen sterility was determined by staining with aceto-carmine and counting the number of stained and unstained grains.

Sterility appears to increase with long as well as short photoperiods, more so in the former case. It is also worthy of note that photoperiodic treatment during the first twelve days has an appreciable effect on pollen sterility. Long-day treatment increases sterility,

TABLE I

Percentage pollen sterility and fertility indices for I.P. 165, I.P. 52 and P.C. 591 wheat (Triticum vulgare) *under different photoperiodic treatments*

Photo-periodic treatment	* Pollen sterility (per cent).			Fertility index		
	I.P. 165	I.P. 52	P.C. 591	I.P. 165	I.P 52	P.C. 591
1 *a*	14·1	21·0	13·8	0·14	0·35	0·06
2 *a*	13·4	19·9	16·4	0·23	0·41	0·23
3 *a*	22·4	15·4	16·7	0·21	0·27	0·22
4 *a*	20·7	16·9	16·9	0·25	0·18	—
5 *a*	19·3	14·9	17·5	0·25	0·15	0·13
1 *b*	2·7	3·4	3·4	0·37	0·44	0·36
2 *b*	2·6	3·4	4·0	0·43	0·39	0·34
3 *b*	1·0	2·4	3·8	0·36	0·40	0·38
4 *b*	3·1	6·7	2·2	0·38	0·41	—
5 *b*	9·8	7·5	8·7	0·31	0·31	0·35
1 *c*	30·4	17·8	23·7	0·13	0·07	0·09
2 *c*	21·7	25·8	21·2	0·17	0·10	0·19
3 *c*	25·5	14·9	19·5	0·14	0·15	0·15
4 *c*	31·5	32·5	25·5	0·10	0·12	—
5 *c*	41·5	30·9	26·2	0·09	0·17	0·13

* Each figure is a mean of 12 observations.

Fertility index within has been calculated by dividing the number of grains per ear by the product of numbers of spikelets per ear and the number of florets per spikelet is also adversely affected by long-day conditions.

The reversible nature of the thermo- and photo-induction effects[2] and abnormalities in development of spike in wheat under the influence of differential photo-treatments, as well as reduction in the number of spikelets and grains under long-day conditions, which have been observed at this Institute (unpublished records of the Imperial Agricultural Research Institute), together with the evidence presented here, as well as the work of O'mara[3] on autotetraploid *Secale cereale* warrant a suggestion that light has an influence on the developmental process in cereals beyond the photophase.

Our thanks are due to Dr. B. P. Pal, and Dr. S. Ramanujam, Imperial and Second Economic Botanists, respectively, for their valuable suggestions and criticisms.

K. K. NANDA.
J. J. CHINOY.
Botany Section,
Imperial Agric. Res. Institute,
New Delhi,
May 30, 1945.

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ON *CASSYTHA FILIFORMIS* LINN.

THE descriptions given for this lauraceous parasite are very meagre and to some extent inaccurate. Some of the latter are given here:

(1) Young parts puberulous (Hooker). They are not so. On the contrary the old stems trailing on the ground are so.

(2) Stem dark-green (Duthie). The extreme tip of the stem is yellow (the first inch or so), lower down it is yellowish green. Further down it is bluish green. The very old stems either dark-green or yellowish brown, the latter colour predominates.

(3) Flowers are 1 inch long when fully formed and fruits 2 inches across (Kanjilal, De and Das). The flowers are hardly 2 mm. across and the ripe fruit including the pulp is not more than 11·0 mm. in diameter lengthwise and 9·30 mm. in diameter equatorwise.

(4) Three bracteoles are present (Duthie). The structures present below the flowers are not bracteoles since they form a part of the flower and lie just below the perianth. When the flower is separated from the inflorescence stalk, these structures also come out and hence they are the epicalyx.

(5) The perianth tube forms the succulent outer covering of the fruit (Hooker). It is not the perianth tube but the perigynous thalamus that forms the outer covering. The perianth is 6, poly-, and in two whorls. Perianth tube cannot be formed in such a case. Moreover this succulent outer covering extends below the true fruit, in between this and the inflorescence stalk, the position naturally occupied by the thalamus.

(6) Whole plants bearing fruits may be dispersed by water (Ridley). This is impossible since the ripe fruit and even flowers and unripe fruits fall down the inflorescence stalk very easily, at just the slightest touch.

C. & S. College,
Shikarpur, Sind, J. SRIVASTAVA.
July 27, 1945.

1. Hooker, *Flora of India*, 1890. 2. Duthie, *Flora of the Upper Gangetic Plains*. 3. Kanjilal, De and Das, *Flora of Assam*. 4. Ridley, *Dispersal of Plants*.

DUAL ARTERIAL SUPPLY OF THE VERMIFORM APPENDIX

THE general impression among the anatomists[1-6] and the surgeons[7] is that the vermiform appendix is supplied by one artery, a branch of ileocæcal artery. In a series of 60 dissections on the Cadaver it was, however, found that in 30 per cent. of the bodies the appendix received more than one artery. In 20 per cent. of these, one twig each from ileocæcal and posterior cæcal arteries; in 8·3 per cent. two from the posterior cæcal artery; and in 1·6 per cent. two from the ileocæcal artery were traced. It is to be noted that whenever the twigs from the posterior cæcal arteries took a total or partial share in supplying appendix, it was always the part nearest the base. These branches, however, are not to be confused with a tiny twig almost invariably given to the base by the posterior cæcal artery.[8]

Even in those cases (70 per cent.) where there was a single appendicular artery it answered to the book description only in 31·6 per cent. In 18·1 per cent., although it was a single branch it immediately divided into two, and in 1·6 per cent. into three twigs, of not inconsiderable size, before entering the meso-appendix. In 18·3 per cent., a single appendicular artery, but a branch of posterior cæcal, was present.

Department of Anatomy,
Dow Medical College, M. A. SHAH.
Hyderabad (Sind), MUBARIKA SHAH.
June 27, 1945.

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ON THE FOOD AND ALIMENTARY CANAL OF THE MILK-FISH *CHANOS CHANOS* (FORSKAL) *

IN the Madras Presidency, the milk-fish contributes to a fishery of moderate scale in the Gulf of Mannar, the Palk Bay and the Pulicat Lake. Its fingerlings, which enter creeks, lagoons and shallow mud flats during the five months from May to September, are collected alive and utilised for cultivation in fish-farms and in brackish and freshwater tanks and reservoirs.

For the purpose of this note, over three hundred specimens, ranging in size from 4 to 43 inches, were examined. The following analysis of the stomach-contents of the fish indicates that it is a plankton feeder: *Conscinodiscus, Fragillaria, Nitzchia, Pleurosigma, Rhizosolenia, Thalassiothrix, Trichodesmium*, Appendicularians, Copepods, fish-eggs, fish-larvæ, larval bivalves, larval gastropods, *Leucifer*, Mysids and species of *Spiratella*.

A study of the anatomical structure of the alimentary canal shows its adaptation to the above kind of food. The mouth is toothless. The pharynx leads into a thick-walled œsophagus, the internal epithelial lining of which is developed into 20-22 oblique plates, on each of which are arranged 15 rows of about seventy spiny papillæ. The œsophagus leads into the stomach, which is a tube developed into a thick-walled muscular gizzard at its pyloric end. Its internal wall is raised into 7 to 9 longitudinal folds. The liver is a bilobed brown structure with the gall bladder placed between the two lobes. The bile duct opens

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into the gizzard by an elliptical opening. The gizzard leads into the intestine through a sphincter muscle. The intestine is a long convoluted tube of uniform thickness. Its anterior portion, the duodenum, is closely apposed to the stomach, and is beset with 120 to 150 brownish tubular pyloric cæca, which open into it by 18 orifices arranged in three yellowish rows of six each. Three cæca are always filled with a yellowish viscid fluid. The internal epithelial lining of the intestine is developed into numerous vascular villii, thus increasing its absorptive surface. The anus is situated closely in front of the urinogenital opening.

It is evident that the structure of the digestive tract of the milk-fish is adapted to its food and feeding habit. The plates of the pharynx act as a filtering apparatus, preventing large and undesirable organisms from entering into the œsophagus. The digestion of the food takes place in the tubular stomach, and is completed in the muscular gizzard, into which the bile duct opens. It is probable that the pyloric cæca are both digestive and absorptive in function. The intestine with its numerous vascular villi is absorptive in function.

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Madras, P. I. CHACKO.
April 26, 1945.

STUDIES IN THE FORMATION OF SULPHUR AT KONA (MASULIPATAM) PART I

IN continuation of our studies[1] of the sulphur formation at Kona near Masulipatam, the soil and the subsoil water in the sulphur-bearing area were found to contain sulphuretted hydrogen, both bound and free; its presence was confirmed by (1) evolution of hydrogen sulphide on acidification of the soils; (2) strong smell of hydrogen-sulphide; and (3) the formation of a heavy black precipitate of lead sulphide on the addition of a solution of lead acetate to the subsoil water.

It was of interest to determine if the production of this sulphuretted-hydrogen was attributable to the direct or indirect activity of micro-organisms.

Samples of soils at various depths from surface up to 6 feet were collected from (*a*) sulphur area and (*b*) non-sulphur area. Weighed quantities of the samples were triturated with measured amounts of sterile water under aseptic conditions and dilutions ranging from 1:10 to 1:100,000 were effected. These dilutions were used for plating out on nutrient agar fortified with the essential inorganic salts. The plates were incubated at 300° C. both under ærobic and anærobic conditions. Plates were counted in duplicates and only those giving a colony count between 30 and 300 were used for the calculation of bacterial populations. The results are shown in Table I.

It may be observed that anærobic population is much larger (2 to 5 times) in the sulphur-bearing area than the corresponding population of the non-sulphur area.

Samples of these soils were inoculated into Van Deldens' medium (Composition KH_2PO_4 grams; Na-lactate 0·5 grams; Asparagin 0·1 gram; $MgSO_4$ 0·1 gram; $FeSO_4$ traces; Tap-water 100 ml.; and agar 2 grams). pH was adjusted to 7·2, and stab cultures were made to secure the growth of the anærobes. Only one sample—collected at 6 ft. in the sulphur-bearing area—showed distinct blackening after four days' incubation at 30° C.

TABLE I

Number of bacteria per gram of soil

Level from surface	Aerobic		Anærobic	
	Sulphur-bearing area	Sulphur non-bearing area	Sulphur-bearing area	Sulphur non-bearing area
0–1′	3,45,000 2,80,000	5,22,000 6,00,000	very few	very few
1½′	65,000 80,000	1,92,000 2,09,000	3000 2200	,,
2½–3′	72,000 79,000	2,56,000 3,14,000	2500 3100	,,
4–4½′	70,000 81,000	2,58,000 3,00,000	6000 7600	3000
6′	30,000 18,000	25,000 29,000	25000 33200	8000 6300

This culture, which apparently included the sulphate-reducing organism, was transferred to a stock medium devised to simulate the environmental conditions of its natural habitat. The composition was as follows:—

$(NH_4)_2SO_4$ 0·1 gm.; $MnSO_4.3H_2O$ 0·2 gm.; $CaSO_4$ (Gypsum) 1·5 gm.; $MgSO_4.7H_2O$ 0·2 gram; NaCl 4·0 gm.; KH_2PO_4 0·2 gm.; $Fe.Am.SO_4$ 0·1 gm.; distilled water 100 ml.

The pH was adjusted to 7·2. After inoculation and incubation at 30° C. under anærobic condition the yellow precipitate turned black in three to four days.

A systematic study of the micro-organism responsible for the reduction of sulphates has been made and the organism characterised as *Vibrio desulphuricans.*, Konæ.

Vibrio desulphuricans., Konæ

Isolation and habitat.—Occurs in the hydrogen sulphide-forming areas at 6 feet below the surface, in ground water and in the sand, occurring at the same depth.

Morphology and staining.—The organism is a spore-bearing short curved rod with rounded ends, roughly 1-2 μ in length, sometimes forming an S-shaped curve, occurring in groups and rarely singly. It stains well with ordinary aniline dyes like Carbolfuchsin, and is decolourised by Gram's method (Gram−ve). Methylene blue stains the organism quite distinctly when kept for 3-5 minutes. The organism is actively motile and appears to possess a single terminal flagellum.

Cultural and Biological.—The organism is a strict anærobe and prefers a specialised media,

The optimum temperature is 30° C., growth being very poor at lower or higher temperatures. The optimal pH is 7·0-7·4. The thermal death point is 60° C.

The organism grows well in liquid media containing sulphates, sodium chloride, phosphates, sodium lactate, and ammonium salts. Presence of traces of iron salts facilitates growth and renders the visual observation of the reduction easy.

The organism does not reduce nitrates. It accomplishes the reduction of sulphites, thiosulphates and free sulphur.

REDUCTION OF SULPHATES IN SOILS OF KNOWN COMPOSITION

Pure acid-washed sand, moistened with the nutrient solution containing all the essential salts, was intimately mixed and dried at 90°C.; this facilitated an even distribution of the salts in the entire mass of the sand.

Cylindrical jars of uniform size (12″× 1½″) were filled first with about one-third its height with the treated sand; 10 ml. of a uniformly suspended active culture added and then covered with an other batch of the same sand. Each jar contained 250 gms. of the sand. The sand in each jar was wetted with compounded sea-water until a head of 1″ of water remained at the top. A control jar with the sand, identically treated, but with no inoculum, was maintained.

Distinct black bands were visible on the fourth day and these bands gradually developed in width upto about the fifteenth day.

It thus seems justifiable to conclude that *Vibrio desulphuricans*., Konæ is responsible for the production of sulphuretted hydrogen formed in the sulphur-bearing area. Further experiments with a view to initiate the process of sulphate reduction in areas other than the sulphur-bearing areas are in progress. We wish to tender our grateful thanks to the Government of Madras for the generous support of a scheme, of which these studies form a part. Our thanks are also due to Sir J. C. Ghosh for his kind interest in the course of these investigations.

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M. SREENIVASAYA.

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Bangalore,
August 31, 1945.

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ELECTRICAL TRANSMISSION AT NERVE ENDINGS

IN previous communications (Singh and Sehra, 1945; Singh, Sehra and Mrs. Singh; Singh, 1945), we have described differences between the effects of stimulation of the frog heart and unstriated muscle by nerves and by acetylcholine. We have now come across frogs the tissues of which show these differences in a more striking manner.

In the present experiments from gastrocnemius was stimulated electrically, through its nerve, or by acetylcholine (1 in 10^5) and frog rectus was stimulated with alternating current by Winton's method or by acetylcholine. The frog gastrocnemius was stimulated alternately through its nerve and by acetylcholine every five minutes, so that the responses to nerve stimulation and acetylcholine were recorded in the same muscle under identical experimental conditions.

The rectus abdominis was insensitive to acetylcholine, but hypersensitive to alternating current (12 experiments). This was surprising in view of the fact that this muscle is used for the assay of acetylcholine. Out of 12 gastrocnemii, 6 were found to be insensitive to aectylcholine (1 in 10^3), and the other 6 gave feeble responses with 1 in 10^5 acetylcholine, but all these muscles were found to be hyperexcitable to nervous stimulation or to alternating current. It was possible to vary the excitability to these two agencies in the opposite directions. Thus in the absence of calcium, the muscle at first became hyperexcitable to nervous stimulation and acetylcholine, but within 15 minutes, it became inexcitable to the former, but remained hyperexcitable to the latter. As the concentration of calcium was increased, the excitability to nervous stimulation increased, and that to acetylcholine decreased, the optimum concentration of calcium for the former being 0·02 M $CaCl_2$. The muscle could thus be rendered inexcitable to acetylcholine and hyperexcitable to nervous stimulation and *vice versa*. Replacement of the chloride of the saline with bromide, nitrate and iodide at first increased the excitability to both, but after ten minutes affected them in opposite directions (Fig. 1).

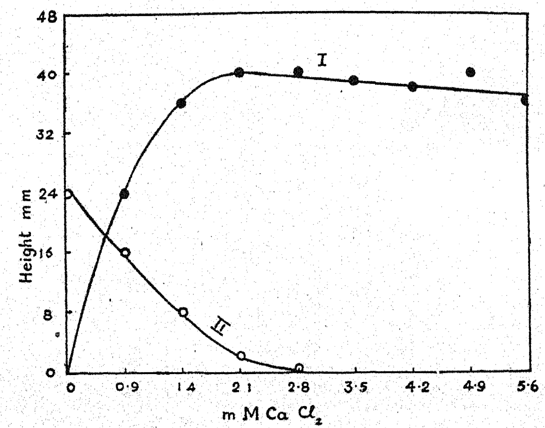

FIG 1.—Frog gastrocnemius. Effect of stimulation through nerve (1st curve) and by acetylcholine (1 in 10^5, 2nd curve) with varying calcium concentration.

Contraction produced by acetylcholine, thus belongs to the potassium group (Singh, 1938), and that by nervous stimulation to the alternating current group. The two are thus antagonistic. As the contraction produced by alternating current is a propagated one, these experiments show that the transmission of the

nervous impulse at the myoneural junction is electrical rather than chemical.

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Dow Medical College,
Hyderabad (Sind),
July 15, 1945.

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APPARENT CAROTENE AND VITAMIN C IN DEHYDRATED VEGETABLES

IT was reported earlier[1] that the purification of crude petroleum ether extracts of carotene by washing with 90 per cent. methyl alcohol is unsatisfactory because some non-carotene, biologically inactive pigments remain in the petrol layer and are estimated inaccurately as carotene. The degradation products which occur in considerable amounts in stored food-stuffs, can be removed by adsorption on a column of dicalcium phosphate. Similar artifacts have been now shown to develop during the dehydration of vegetables and increase on subsequent storage.

An aliquot of the extract, after phase partition was purified by chromatography and the unadsorbed carotene estimated on the Pulfrich photometer. A considerable portion of the "carotene" in the epiphasic layer consisted of some degradation product exhibiting a non-specific absorption spectrum and being chromatographically separable from carotene. It is reported[2] that carotene is reasonably stable in dehydrated vegetables, but when estimated by this method, the loss appears to be serious.

TABLE I.—*Carotene μg. per gram of vegetable on moisture basis*

Vegetable	Fresh			Dehydrated			Dehydrated and stored				
	Phase partition	Chromatography	Non-carotene pigment	Phase partition	Chromatography	Non-carotene pigment	Period of storage	Phase partition	Chromatography	Non-carotene pigment	Loss in carotene
			%			%	Weeks			%	%
Bitter-gourd	25·7	25·7	0	24·1	23·6	2·0	8	22·8	16·6	27·2	35·3
Carrots	855	850	0·6	842	812	3·6	8	469	452	3·7	46·9
Spinach	727	—	—	567	428	24·6	9	331	223	30·6	69·3
Cabbage	341	341	0	280	214	23·6	11	155	74·4	52·0	78·2

The vegetables were dehydrated as recommended by Prescott and Proctor[3] and stored in air-tight tins at room temperature.

Mapson's[4] observation that dehydrated vegetables contain reducing substances which interfere with the estimation of ascorbic acid by titration with 2 : 6-dichlorophenolindophenol has been confirmed. Ascorbic acid was determined in vegetables—fresh, blanched, dehydrated, and stored after dehydration—by the method of Harris and Olliver[5] and by the improved method of Mapson where correction can be applied for the non-specific reductants. The results given in Table II indicate that the artifacts which appear to be mainly reductones are developed during the dehydration and increase on storage.

These results emphasise the need for employing the improved technique for the accurate estimation of carotene and ascorbic acid in dehydrated vegetables.

TABLE II.—*Ascorbic acid in mg. per 100 g. of vegetable on moisture-free basis*

Vegetable	Treatment	Harris and Olliver's method	Mapson's method	Non-ascorbic acid reductants
				%
Potato	Fresh	104	104	0
	Blanched	107	107	0
	Dehydrated	71·0	70·2	1·2
	Dehydrated and stored for 16 weeks	19·7	12·7	35·5
Bittergourd	Fresh	1480	1480	0
	Blanched	1177	1177	0
	Dehydrated	193	154	20·0
	Dehydrated and stored for 8 weeks	130	100	23·2
Cabbage	Fresh	549	549	0
	Blanched	439	439	0
	Dehydrated	300	264	11·9
	Dehydrated and stored for 10 weeks	40·2	23·9	40·4
Spinach	Fresh	414	414	0
	Blanched	281	281	0
	Dehydrated	92·9	53·9	42·0
	Dehyrated and stored for 9 weeks	0	—	—

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August 31, 1945.

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REVIEWS

Portraits of Famous Physicists with Biographical Accounts. By Henry Crew. (New York: Scripta Mathematica, Yeshiva College), 1942.

In 1937, the editor of the *American Physics Teacher*—now of the *Amercian Journal of Physics*—appointed a committee to plan a portfolio of portraits of eminent physicists, to be published by Scripta Mathematica. The committee contained seven members. It was decided to choose twelve outstanding physicists out of the fifty names submitted for consideration. The selection was to be made from among those not then living.

In February 1938, the following names were selected—Galileo, Huygens, Newton, Ampere, Fresnel, Faraday, Joule, Clausius, Maxwell, Gibbs, Hertz and Rowland. While it is possible to suggest other names for this gallery of twelve, there can hardly be any doubt that these eminent physicists are genuinely great. The period covered by these very distinguished men extends from 1564 (when Galileo was born) to 1903 (the year of the death of Gibbs).

Henry Crew, a member of the committee, has given brief biographical sketches. Emphasis has naturally been laid in each sketch (limited to 800 words) to the outstanding work of the physicist concerned.

The portraits of the twelve distinguished men of science have been taken mostly from contemporary paintings or photographs. The reproductions are attractive and elegant. Facsimiles of letters or parts of written scientific papers are given here and there. These add greatly to the interest of the collection.

S. R. R.

Animal Biology. By A. J. Grove and G. E. Newell. Second Edition. (University Tutorial Press, London), 1945. Pp. viii + 678. Price 16 *Sh.*

The book before us is the second edition of this recent work on elementary biology first published in 1942. The need for a second edition in so short a time is itself a good indication of the very favourable reception that has been accorded to this volume.

In recent times a very notable change in the method of imparting instruction in Biology has taken place. The older method placed great reliance on the type system, a full understanding of a single species being considered the most efficient way of assessing characters that define a group. The method has the advantage that the descriptions given are very precise and often demonstrable in practical work. In actual practice, however, the type method of treatment is apt to underrate the value of comparative study and, often, the plasticity of life in the animal series and variation within orders and phyla are lost sight of. The increasing importance of the functional aspect of animal life has been indicated only in a comparatively small number of text-books. The authors of *Animal Biology* have tried to remedy both these defects. There is a very successful combination of the type method and the comparative treatment; the relation of animal to its environment and the physiological significance of structural features noticed have received attention and emphasis where necessary. The result is an admirable work on Elementary Zoology containing reliable and up-to-date information on biological principles.

The criticisms that one may offer are more of the nature of points of view rather than defects in treatment. In the opinion of the reviewer the omission of Molluscan and Echinoderm types from Part II dealing with metazoan types is certainly a drawback in presenting a well-balanced account of the invertebrates. The sections dealing with vertebrates are particularly to be commended because it is here that the authors have brought in much advanced information on comparative anatomy in a very logical sequence and without subordinating to the description of types. In the method of treatment which most teachers adopt, comparative anatomy of vertebrates is often removed from the detailed treatment of types with the result that the subject loses much of its interest and is often gone through as a necessary rather than a logically developed theme. The departure presented here is a welcome one. The account of chordate embryology is likewise knit into a continuous account of comparative changes taking place during the development of Amphioxus, the frog, the chick and the rabbit. Part VI dealing with Genetics gives a good summary of the subject but the general treatment is not so happy as in the former sections. The last chapter of the book entitled "The Animals' Background" is an original feature and contains much essential information that is often, unfortunately, ignored. On the physiological side it is very pleasing to find the readable accounts of the physiology of sight, the mechanism of hearing, the mechanism of nerve impulses, the behaviour of endocrine systems both in Invertebrates and Vertebrates and the recent work on the physiology of excretion in relation to osmoregulation. The book is very well illustrated; many of the figures are original. A few like Fig. 34 on page 71 and those in the last chapter are not in keeping with the high quality of the other illustrations. The selection of Fig. 11 on page 29 is unfortunate as it does not show the orthodox posture of the Anopheline mosquito. The statement on page 176 in connexion with the green glands of *Astacus* that the fluid within the excretory organs is at a lower osmotic pressure than the blood is misleading; in actual fact the lower osmotic pressure is observed only in the final urine in the bladder, the initial urine being isotonic with blood. Fig. 367 on page 464 with the corpus luteum marked as an unshaded area seems to give a false idea of its structure.

This book can most confidently be recommended to teachers and students alike as a very sound introduction to the study of animal biology. N. K. PANIKKAR.

Principles of Irrigation and Drainage. By K. M. Gururaja Rao, L.Ag., Principal (Retd.), Mysore Agricultural School, Hebbal, Bangalore. (The Bangalore Press, Mysore Road, Bangalore City), 1945. Pp. 50. Illustrations 18. Price Rs. 2.

This timely publication will be found useful against the background of converging efforts of Governments to increase irrigation schemes to insure sustained crop-production against the vagaries of the monsoons. The subject is handled from the standpoint of agricultural needs down to correct methods of application of water on the fields. Books of this type serve to fill in an admirable way the *lacuna* that is growing between theoretical recommendations spread through a number of books on one hand, and the practical needs of the cultivator on the other.

The subject is clearly analysed and presented in five chapters under Irrigation, and four under Drainage. They deal with various aspects of the subject such as: History of irrigation and advantages, soil in relation to irrigation, three ways how water is held in the soil, sources of irrigation water, duty of water, water-lifts, and nine methods of field irrigation. The subject of drainage consists of: Nature of soil in drainage, kinds of drainage, surface "Run-off" of water, discharge-coefficient, different kinds of drains and benefits of sub-surface drainage. There is a small chapter on Alkali soils, with a few suggestions for reclaiming them.

The contents of this attractively got-up volume represent the exceptionally rich and valuable experience, which the author was able to gain during his twenty-five years of intimate association with large-scale irrigation farming; the publication will be welcomed as a practical handbook on the subject.

Animal Colony Maintenance. By E. J. Farris, F. G. Carnochan, C. N. W. Cumming, S. Farber, C. G. Hartman, F. B. Hutt, J. K. Loosli, C. A. Mills and H. L. Ratcliffee. (*Annals of the New York Academy of Sciences*, 46, Art. 1. Published by the Academy, New York), 1945. Pp. 126.

Recent advances in physiology, pathology, pharmacology and particularly in nutrition are largely based on results obtained through animal experimentation. The increasing use of animals for research in these fields calls for the scientific maintenance of a healthy, clean and vigorous stock showing little or no variation from colony to colony. A standardized animal is to the biologist or to the nutritionist what the pure chemical is to the chemist. It is not often recognised that the animal is a delicate bit of apparatus and that the maintenance of a reliable and healthy colony is a complicated problem demanding considerable experience and care. The difficulty of the problem is illustrated by the fact that the simple removal of rats from one building to another may stop breeding for several months. The various aspects of the problems involved were ably discussd at the recent Conference on Animal Colony Maintenance organised by the New York Academy of Sciences, each aspect by a specialist in the field. Six topics are dealt with: genetic purity, mating of mammals, feeding of laboratory animals, environmental influences, infectious diseases, and financial considerations.

The six papers presented at the Conference together with the discussion they provoked have now been published in book form. The introductory speech by Dr. Farris of the Wistar Institute is also included. The papers are all of a high scientific order and are fully referenced. The proper feeding of the various species of laboratory animals and their requirements of the various dietary essentials are dealt with as thoroughly as the many intricate details concerning their œstrus cycle. The infectious and parasitic diseases of laboratory animals are also amply dealt with. The financing of animal colony maintenance has been considered both from the point of view of research organisations and of the commercial breeder. So far as India is concerned, the commercial breeder is almost non-existent, and perhaps rightly so. Most research organisations maintain their own animal colonies reared successfully through generations, and as such the commercial breeder may not have much encouragement.

The book is a mine of information and should prove extremely useful to those concerned with animal experimentation.

S. RANGANATHAN.

Further Work on Plant Injection for Diagnostic and Curative Purposes. By W. A. Roach and W. O. Roberts. (Imperial Bureau of Horticultural and Plantation Crops. Technical Communication No. 16), 1945. 1*s.* 6*d.*

At the East Malling Research Station, Kent, England, work on plant injection for diagnostic and curative purposes is being carried out by Dr. Roach and his collaborators for the past many years. In 1938, Dr. Roach surveyed the whole work of plant injection giving details of technique used by himself and others in Technical Communication No. 10, of the Imperial Bureau of Horticultural and Plantation Crops. Since then much advance has been made in the technique by workers in this field and if it were not for the stress of war the Imperial Bureau of Horticultural and Plantation Crops would have brought out another technical communication reviewing the whole work up-to-date. Since this was not possible under the present circumstances, Roach and Roberts in Technical Communication No. 16, have had to confine themselves only to a description of the improvements effected in the injection technique by the East Malling group of workers.

The authors have furnished a list of solutions together with their concentrations which have given responses when tested on a number of plants. The use of these solutions may require modifications when work is done on new kinds of plants. A detailed description is given of the *inter-veinal* and *leaf-stalk* injec-

tion methods which have proved so successful. Since the appliances required for plant injection work are small and require care in handling, details of their construction are given and very clearly illustrated with several text-figures. The results of the extensive work of the authors and their collaborators on plant injection have been briefly summarised in respect of twenty-five different kinds of plants which mainly consists of fruit trees and vegetable plants.

The technique adopted for injection for curative purposes is dealt with under the two heads, *injection of liquids* and *injection of solids*. The latter method being necessary in the case of trees that cannot absorb fluids. The injection of solids necessitates drastic operation on the trees yet it is less elaborate, requires fewer appliances and is more easily carried out.

The techniques described in the communication under review are an improvement over those previously used and described and will be found by workers in the field easy of application.

L. S. S. Kumar.

SCIENCE NOTES AND NEWS

The Age of the Punjab Saline Series

In the course of his Presidential Address to the National Academy of Sciences at their Annual Meeting held at Hyderabad (Deccan) in December 1943, Prof. Birbal Sahni of Lucknow reported the discovery of numerous micro-fossils, mostly plant remains, in the rock salt and Kallar of the saline series, as also in the associated gypsum and oil shales; and having satisfied himself regarding the undoubted *in situ* character of these fossils, Prof. Sahni pointed out that the testimony of these fossils was obviously entirely opposed to any idea of the saline beds being so old as the Cambrian; it was clear on the evidence of these fossils, he said, that the beds were certainly Tertiary, and probably belonged to the Eocene period. Prof. Sahni's researches in this field have been more intensively pursued from various aspects during the year 1944, and a full review and discussion of the entire evidence he has collected was embodied in his Presidential Address to the National Academy at their Poona meeting held in December 1944.

In view of the fact that the problem of the age of the saline series is one of the oldest major controversies of Indian Geology, and has "exercised the brains of some of the foremost geologists who have laboured in this country", Prof. Sahni's recent work naturally attracted considerable attention at once and stimulated a thorough review and discussion of all the available evidence—stratigraphical, structural, and palæontological—bearing on this question of the Cambrian *vs.* the Eocene age of the Punjab salt. A special Symposium on this subject was organised at Poona in December 1944 under the joint auspices of the National Academy of Sciences, and the Indian Academy of Sciences, and the papers read at this important meeting have been just published in the *Proceedings of the National Academy* (Section B, Vol. 14, pt. 6). Among the contributors to this symposium, the names of practically all the leading workers in this field appear—C. S. Middlemiss, E. H. Pascoe, C. S. Fox, D. N. Wadia, E. Lehner, E. S. Pinfold, and L. M. Davies,—and there are, in addition, two valuable contributions by E. R. Gee to whom "we owe the most detailed survey of the salt range area since the time of Wynne".

It is hardly possible in the course of this short review to refer to the points raised and comments made by these authors; a perusal of their papers will serve to show how sharply and strongly the opinion is still divided on this question. The whole problem "is again in the melting pot", and the controversy is becoming positively exciting. The Symposium is to be continued at a joint meeting of the Academies to be held at Udaipur in December 1945; and all geologists will be keenly looking forward to the further developments in this field in the hope of arriving at a really final solution of this most intriguing and tantalising problem in Indian Geology.

MAGNETIC NOTES

Magnetic conditions during August 1945 were slightly less disturbed than in the previous month. There were 21 *quiet* days and 10 days of *slight* disturbance as against 19 *quiet* days, 11 days of *slight* disturbance and 1 day of *moderate* disturbance during the same month last year.

The quietest day during the month was the 9th and the day of the largest disturbance the 22nd.

The individual days during the month were classified as shown below:—

Quiet days	Disturbed days
	Slight
1, 3–5, 7–11, 16–21, 23–25, 29–31.	2, 6, 12–15, 22 26–28.

No magnetic storms occurred during the month of August 1945, while one disturbance of moderate intensity was recorded during August 1944.

The mean character figure for the month of August 1945 was 0·32 as against 0·42 for August 1944.

A. S. Chaubal.

ERRATA

In the note entitled "A Note on Hotelling's T^2," appearing in Vol. 14, No. 7, July 1945 issue, in page 173, column 2, delete the 13th line reading "industrial and technical establishments trough".

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CURRENT SCIENCE

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PLANNING OF RESEARCH

EARLY in 1944, the Government of India constituted a Research Planning Committee in accordance with the resolution of the Governing Body of the Council of Scientific and Industrial Research, to survey the existing facilities for scientific and industrial research in India and to "report on necessary measures of co-ordination, control, direction and development of such research by various agencies and also on other steps necessary for the planning of research in post-war India". The Committee's work was interrupted for a short time due to the absence of the Chairman in the U.S.A. on official duties and in the final stages, the Committee was denied the benefit of advice and collaboration of three members, Sir S. S. Bhatnagar, Sir J. C. Ghosh and Prof. S. K. Mitra, on account of their visit to England and America as members of the Delegation of Indian Scientists.

The Committee circularised two sets of questionnaire—one to the various universities, research institutes and Government departments interested in scientific and industrial research, and the other to industrial firms and chambers of commerce. To obtain a first-hand knowledge of the existing facilities for research, the Committee visited important centres of scientific activity and had personal discussions with scientific workers, university representatives and leaders of industry and commerce at some of these centres. The facts obtained through these channels have been critically appraised and presented in a comprehensive document* which also includes the recommendations of the Committee with regard to post-war planning of pure and applied research.

The Committee in its report records that the present research activity in India does not represent even the bare minimum whether judged by international standards or by the actual requirements of the country in her present state of industrial development. The need for research is felt not only for facilitating an adjustment to post-war conditions but also for promoting the general cause of industrialisation at a time which will be rendered much more difficult by the forces of international competition. The capacity of Indian industry to withstand international competition will depend materially on its vision and its readiness to implement the latest results of research in a continual effort for improving its productive efficiency by economy in the use of raw materials, utilisation of by-products, reduced power cost, and so on. Research will also play a decisive part in the development of new industries for which the opportunities remain imperfectly explored.

Industrial research, in this country, is still in its infancy. Besides the lack of an effective link between our principal research institutions and the industrial interests concerned, a further obstacle to the inception of a suitable research atmosphere has been created by the fact that while Industry constitutes a Provincial subject, it is beyond the resources of most of the provinces to build up adequate research organisations for catering to the needs of local industries. The institutes set up by the Government of India have remained much too centralised for meeting the various regional needs. Moreover, industry, with some rare exceptions, has not become research-minded. Nor there is an effective *liaison* between industry and the research organisations.

If scientific and industrial research is to make any headway in India in the immediate future, the Committee feels that Government must take the initiative in setting up a suitable machinery for the development of research along sound lines, strengthen the science departments of universities and existing research institutions and bring about an effective co-ordination amongst all the institutions. For stimulating and directing scientific and indus-

*"Report of the Industrial Research Planning Committee, Council of Scientific and Industrial Research," 1945. Price Rs. 3.

trial research on a planned and comprehensive basis, the Committee recommends that the Government of India should forthwith set up a central research organisation to be called the National Research Council. This organisation would consist of representatives of scientists, universities, industry, labour and administration. The Hon'ble Member in charge of Planning and Development is suggested to be its *ex-officio* President. The Council, which should be an autonomous body, should have a total membership of 60 made up of 20 scientists elected by the universities and recognised scientific associations, 15 members elected by recognised chambers of commerce and associations of manufacturers, five members elected by recognised trade unions and other labour organisations, and 20 members nominated by the Government of India of whom not more than 8 may be official. Of these two should represent the railway administration.

The functions of the Council will be as follows:—

(1) to organise and maintain national laboratories;

(2) to establish and maintain specialised research institutes;

(3) to stimulate pure and applied research in universities by grants-in-aid and by the institution of scholarships and fellowships;

(4) to provide for the immediate problem of the dearth of technical and research personnel by the inauguration of scholarships available in India and abroad;

(5) to stimulate and escourage research activities by industry;

(6) to co-ordinate research activities of all the existing research institutes and departments of Government and undertake planning of research programmes on a comprehensive basis;

(7) to function as a National Trust for Patents;

(8) to set up a Board of Standards and Specifications;

(9) to function as a Clearing House, encourage deserving scientific and technical societies and foster the growth of new ones on appropriate lines.

A small executive body to be called the Research Board will be responsible for the administration of the work of the Council. The Board will be in charge of all the research laboratories and institutions set up by the National Council and directors of these institutions will be under the control of the Board. It will also maintain the closest contact with Directors of laboratories engaged in industrial research under the administration of the other departments of the Central Government. The Board will prepare comprehensive plans of research programmes and will take an active part in the establishment of research institutions by industries and distribute grants-in-aid to universities and other approved institutions with the help of the Grants Committee from funds specially allotted for the purpose.

The Committee recommends that the Council, given a bulk grant of Rs. 6 crores spread over five years, should make and carry out (*i*) the building and equipment of National Chemical and Physical Laboratories, (*ii*) the building and equipment of certain specialised research institutes; (*iii*) giving grants-in-aid to universities for strengthening their research organisation, and (*iv*) training of research personnel by the award of scholarships tenable in India and abroad.

The establishment of a National Chemical and a National Physical Laboratory is recommended each at an estimated cost of Rs. 40 lakhs. It is further recommended that in the absence of industrial research associations in India (except for jute and tea) it is necessary for the State to take the initiative for the establishment of a number of specialised laboratories for fulfilling the object. Nine new specialised institutes are recommended in the following order of priority:—

Institute of Food Technology; Metallurgical Institute; Fuel Research Institute; Glass and Silicate Research Institute; Oils and Paints Institute; Buildings and Road Institute; Leather and Tanning Institute; Industrial Fermentation Institute; and Electro-Chemical Institute.

These specialised research institutes will deal with problems of basic and specific research relating to their respective spheres. Provincial and State Research Councils may send problems for investigations to these institutes and it will be open to individual manufacturers to refer specific problems of immediate interest to industry to such laboratories on payment of scheduled fees or by the establishment of fellowships.

The Committee considers that universities constitute the foundation of all research and suggests the strengthening of scientific teaching and research work in Indian universities. As an essential part of the five-year plan, the Committee recommends that the National Research Council should make substantial grants for strengthening the scientific departments of the universities. For this purpose the Grants Committee should make a survey of science and research departments of all the Indian universities and recommend to the National Research Council a scheme of financial assistance to the latter. Out of the bulk grant of Rs. 6 crores, the Committee says, a sum of about Rs. 2 crores should be set aside for giving grants-in-aid to the 19 universities. Further, adequate engineering research sections should be in contact with the engineering colleges. Teachers in such colleges should be in contact with the engineering industries.

To man the various laboratories proposed to be set up and to keep alive the research work in the country the Committee recommends that 700 research workers should be trained in five years involving an estimated total expenditure of about Rs. 50 lakhs: Rs. 27 lakhs for foreign scholarships and Rs. 23 lakhs for Indian scholarships. Industries should be encouraged to set up their own research associations on corporate basis by exemption of research expenditure of firms from income-tax assessment.

A network of corresponding research organisations should be set up in Provinces and major States. It is recommended that research councils on the model of the National Research Council composed of the representatives of

scientists, industry and administration, should be set up in all the Provinces and major States.

A suitable method for the exploitation of patents in respect of inventions made at either the national laboratories or universities and other research organisations should be evolved. A National Trust of Patents should be set up for the purpose of holding and exploiting all patents resulting from research financed by Government and those dedicated by individual scientists and by institutions, supported either by public funds or private endowments.

The institution of a Board of Standards for drawing up Indian standard specifications and the establishment of a technological institute on the lines of M.I.T. are recommended.

The Committee emphasises that research can yield its best results only when it is backed by a comprehensive industrial plan. This will not only inspire enthusiasm among research workers but will serve the practical purpose of indicating an order of priority in the various lines of investigation. The Committee accordingly recommends that the National Research Council must work in close co-operation with the department of Industrial Planning so that industry and research will each stimulate the other.

The Committee further emphasises the organic relationship between the different categories of research, *viz.*, agricultural, medical and industrial, and welcomes the constitution of the Scientific Consultative Committee in the Department of Planning and Development as a body expected to secure the necessary co-ordination at a high level. The Committee, however, considers it necessary to examine the possibility of bringing all the research activities of the various Government departments under the administrative control of the Member for Planning and Development.

RESINATED FABRIC LAMINATES

THE development of jute fabric-shellac laminates by the Indian Jute Mills' Association, an account of which appeared in this *Journal* last month (August 1945, pp. 202-03), provides an appropriate opportunity for reviewing briefly the basic work carried out in India on the subject of resin-impregnated fabrics which find numerous industrial applications. The work dates back to 1926, when successful investigations on a laboratory scale were carried out in the *University Chemical Laboratories, Lahore*. The commercial possibilities of the products attracted wide attention, and at least two Indian industrialists, one from Calcutta, and another from Cawnpore, came forward to finance the development work on fabric-shellac laminates, particularly for constructional purposes and for the production of containers. When the *Board of Scientific and Industrial Research* was inaugurated in 1940, the problem of resinated fabrics was taken up once again for detailed investigation. Metal containers were in short supply and there was an urgency for finding substitute materials. Resinated laminates of textile materials and paper suggested themselves as suitable substitutes, providing wide scope for the development of a large range of containers. A considerable amount of basic work, both on the methods of spreading resin on fabrics and on processing them, was carried out. Successful processes were developed for the manufacture of resinated laminates both of fabrics and of paper, in the laboratories of the *Board* (*cf.* Indian Patent Nos. 28277 and 28281) and handed over to industry and army for exploitation and development.

The application of shellac or other resins to fabrics, which is the primary process in the production of this class of materials, can be carried out in one or the other of the following ways: (1) dusting shellac or applying molten lac without the use of any solvent, but using only wetting agents, and passing the treated material between hot rollers to ensure uniform spreading of the resin, (2) impregnating with aqueous dispensions of powdered shellac, and (3) impregnating solutions of shellac, in solvents selected for their easy availability or cheapness or processing advantage. The resin coated materials are further processed to obtain laminates. They can be passed between hot rollers or compressed in hydraulic presses to obtain products of any desired compactness and finish. A variety of samples were prepared in the laboratories of the *Board of Scientific and Industrial Research* by employing various methods of spreading shellac and of processing the treated fabrics. For the production of unburstable containers (Indian Patent No. 28247) solutions of shellac in alcohol or ammonia were employed, and for jettison tanks, required by the U.S.A. Air Force, either dispersions of shellac in water, or molten lac with extenders or wetting agents, were preferred. It is obvious that for the production of laminates on a commercial scale, one or the other of the methods investigated in the laboratories of the *Board of Scientific and Industrial Research* or modifications thereof, will have to be employed. Wartime successes have been determined largely by the availability of processing materials and manufacturing equipment, and recourse had to be taken often to alternate processes as expedients, such as the *one* developed by the Indian Jute Mills' Association, for securing immediate results. As the emergency conditions, do not obtain any longer, future developments will be determined largely by the quality of the products and the efficiency of the processing techniques. The laminated boards have already found use in the production of a large number of useful products (*cf.* Indian Patent No. 30680). We are glad to learn that the processes developed by the scientists in their research laboratories are being increasingly utilized by industry. This is to be welcomed. History teaches us that every development of an enduring character originated in a research laboratory. It is appropriate that the *Council of Scientific and Industrial Research* has been pursuing an enlightened and liberal policy with regard to the processes developed in its research laboratories, which aims at providing all possible assistance to industry. Further applications of resinated laminates envisaged by the work of the *Council* will be watched with keen interest.

ALTERNATE MEDIA FOR LARGE-SCALE REARING OF THE RICE MOTH—*CORCYRA CEPHALONICA* ST., IN THE WORK OF MASS-PRODUCTION OF THE EGG-PARASITE *TRICHOGRAMMA MINUTUM* R.

By B. KRISHNA MURTHI and D. SESHAGIRI RAO
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IN the United States of America, West Indies and other countries, wheat is used for large-scale rearing of the Angumois moth (*Stitotroga cerealella*, Ol) on the eggs of which the parasite *Trichogramma evanescens* Westw. is multiplied in connection with the biological control of the sugarcane stem-borer (*Diatrœa saccharalis* F.). For the mass production of *Trichogramma minutum* R.—the local egg-parasite of the cane-borer, *Argyria sticticraspis* Hmp., Jowar (*Andropogon sorghum*) was the medium selected as the most suited for mass rearing of the Rice moth *Corcyra cephalonica* St. on the eggs of which it was decided to breed the egg-parasite (*Trichogramma minutum* R.).

In 1943, however, owing to the shortage of foodgrains in the country and the consequent difficulty in obtaining adequate supplies of jowar for this purpose, it became necessary to find alternate materials which would be acceptable to the Rice moth, inexpensive and abundant. Mixtures of tapioca and wheat and rice brans were tried as possible alternatives to jowar. Tapioca alone, however, not being considered conducive to the proper development of the moths (as was later shown by actual tests) it was decided upon to mix it with a sufficient quantity of some material that would make up for the protein deficiency in tapioca. The Agricultural Chemist suggested an admixture of about 20 per cent. bran (of wheat or rice) with tapioca. Further, previous work with jowar in this laboratory having shown the value of incorporating yeast in the medium and as had already been definitely shown by Swamy and Sreenivasaya,[1,2] that *Corcyra cephalonica* St., fed on a diet deprived of its vitamin B_1, showed a poor growth, etc., it was thought advisable to enrich the mixture of tapioca and bran with some yeast. A quantity of 2 per cent. yeast was considered adequate for the purpose by the Agricultural Chemist. A mixture, namely, of 79 per cent. tapioca, 19 per cent. bran and 2 per cent. yeast was, therefore, finally employed in the tests with tapioca discussed here.

These trials were conducted in large-sized petri-dishes each of which 10 gm. of material was put in and 100 freshly-laid eggs of *Corcyra* were sprinkled on the surface and the dishes covered with tight-fitting wire-gauze covers. These dishes (ten in number) were enclosed in a specially-devised wooden cupboard in which small dishes containing water (replenished daily) were kept in order to keep the requisite humidity. This work extended from April to June 1943 when the average internal temperature of the rearing cupboard was 77·1° F. (average room temperature = 78·0° F.); the range of variation between the cupboard and room temperatures was, therefore, slight, not more than ± 1·0° F. on any day.

Tests were conducted with tapioca alone and with yeast, tapioca in combination with wheat bran and rice bran (with and without yeast) and with jowar and also with wheat bran and rice bran. Jowar was set up separately as a control for assessing the relative usefulness of tapioca, wheat bran and rice bran. The following combinations with tapioca were set up:

TABLE I

1.	Tapioca 98 gm.	+ Yeast 2 gm.		
2.	do. 80 ,,	+ Jowar 20 ,,		
3.	do. do.	+ Rice bran 20 gm.		
4.	do 79 ,,	+ Rice bran 19 ,,	+ yeast 2	
5	do. 80 ,,	+ Wheat bran 20 ,,		
6.	do. 79 ,,	+ ,, 19 ,,	+ yeast 2 gm.	

Results of rearing the Rice moth in different media

No.	Nature of medium	Period of Development of first moth (days)	Percentage of emergence	Emergence period (days)	Size of moths (Average)				Fecundity (No. of eggs per moth)	Longevity (in days)	
					Length	Wing-Exp.	Length	Wing-Exp.	Ave.	Paired	Unpaired
					mm.	mm.	mm.	mm.			
1	Tapioca	No Emergence									
2	Tapioca + Yeast	do.									
3	Tapioca + Rice bran	43	25	42	8·0	17·5	7·3	14·4	152 10	11·6	12 15
4	Tapioca + Rice bran + Yeast	44	33	41	8·2	18·5	6·3	13·3	149 8	12·5	8·3 13
5	Tapioca + Wheat bran	38	54	48	8·3	18·3	7·2	14·6	129 8·3	14·3	8·0 14
6	Tapioca + Wheat bran + Yeast	42	61	36	8·7	18·1	7·6	15·0	192 9·2	12·6	9 15
7	Tapioca + Jowar	40	37	42	8·6	19·0	7·5	15·0	171 8	9·	8·2 15
8	Ricebran	41	40	42	8·4	19·1	7·4	15·8	133 10·3	13·7	9 17
9	Wheat bran	28	100	34	9·5	20·6	8·5	18·0	158 5·3	5·5*	Not noted
10	Jowar (Control)	39	58	42	8·7	19·8	7·9	15·3	179 8	12	9 15

In each medium the period of development (of the first moth to emerge), percentage of emergence, the total emergence period (from the first to the last moth), average size, longevity, and fecundity of the emerging moths were worked out and are discussed briefly below. The table records the data.

(1) *Period of development.*—Varied from 28 days in wheat bran to 44 days in tapioca + rice bran + yeast (jowar 39 days). There was no emergence of moths at all from tapioca or tapioca + yeast.

(2) *Percentage of emergence.*—Ranged from 25 in tapioca + rice bran to 100 in wheat bran (jowar 58).

(3) *Emergence period.*—Ranged from 34 days in wheat bran to 48 days in tapioca + wheat bran (jola 42 days). The development of *Corcyra* is known to be irregular and consequently the emergence period fairly long, about six weeks in jowar.

(4) *Average size of moths.*—Moths emerging from tapioca + rice bran were the smallest of the series, and those from wheat bran, the biggest, actual measurements being as follows:

TABLE II

Medium	Female		Male	
	Length	Wing-Exp.	Length	Wing-Exp.
Tapioca + Rice bran	8·0 mm.	17·5 mm.	7·3 mm.	14·4 mm.
Wheat bran	9·5 ,,	20·6 ,,	8·5 ,,	18·0 ,,
Jowar	8·7 ,,	19·8 ,,	7·9 ,,	15·3 ,,

(1) *Longevity.*—It was observed that the male moth generally lived longer than the female, and that the mated moth (male or female) had a shorter span of life than an unmated moth of the same sex; males, some of which confined singly in tubes lived quite long, up to 34 days in one case.

(2) *Fecundity.*—In every medium 6 pairs of moths (male and female moths of the same pair emerged on the same day) were mated and each pair was confined in a specially constructed cylindrical oviposition cage having a wire-mesh bottom fitted up in the middle, and with a wire-mesh lid. The cage with the two moths enclosed inside was placed upright in a petri-dish till the death of the female moth, and the eggs laid on each day was recorded. Generally, the bigger female moths were found to lay more eggs than the smaller ones. The highest average number of eggs per female moth is 192·6 in tapioca + wheat bran + yeast, and the lowest average is 129 in tapioca + wheat bran (jowar 179). The largest number of eggs laid by a single female moth in the entire series was 374 in tapioca + wheat bran + yeast.

The relative suitability of the different media for *Corcyra* rearing may be stated as follows:—

(1) *Wheat bran.*—In this material the total developmental period of the entire brood (total of columns 3 and 5 of the table) was the shortest (62 days) and the rate of emergence the highest (100 per cent.) of the whole series; this substantial reduction of two to three weeks in the developmental period compared to other media provides an extra generation of moths for every three generations produced which is a decided advantage in continuous and large-scale rearing. The moths emerging from it were the biggest in size with a fairly high fecundity.

(2) *Tapioca + wheat bran + yeast* requiring 78 days for total development and giving 61 per cent. emergence came next in order being more or less parallel in this respect to jola (81 days and 58 per cent.). The moths emerging from this material, though of a medium size showed the highest egg deposition rate of the whole series, presumably due to the presence of yeast in the mixture.

(3) *Tapioca + wheat bran* is obviously a less suitable medium than the above, as it has a longer developmental period (86 days) and a lower rate of emergence (54 per cent.). The average fecundity is, however, the lowest of the entire series in striking contrast to tapioca + wheat bran + yeast.

(4) *Rice bran* (83 days and 40 per cent.), *Tapioca + Jola* (82 days and 37 per cent.), *Tapioca + Rice bran + Yeast* (85 days and 33 per cent.) and *Tapioca + Rice bran* (85 days and 25 per cent.) appear to be comparatively unfavourable media owing to the protracted development coupled with the poor emergence in them.

(5) *Tapioca* and *tapioca + yeast.*—There was no emergence of moths from these media.

In conclusion, it may be stated that while tapioca alone, or mixed with yeast is unsuited for *Corcyra* rearing (though the later instar larvæ are capable of feeding on it to some extent), mixed with bran or jola, it is capable of supporting the rice moth. (This clearly emphasises the importance of some protein material for successful development in insects.) Wheat bran is seen to be a very good medium for this work in every respect being superior even to jowar; Rice bran, on the other hand, is not a very satisfactory medium.

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HAFFKINE INSTITUTE*

THE Haffkine Institute, first started as a plague research laboratory, has, under the able and enlightened Directorship of Lieut.-Col. S. S. Sokhey, extended its wings and achieved spectacular progress with nearly fifty members on the rolls of the scientific staff, there are now nine departments functioning—the departments of Vaccines, Antitoxins and Sera, Pharmacology, Biochemistry, Chemotherapy, Entomology, Nutrition and Experimental Pathology, Clinical Pathology and Virus Diseases including Rabies; in addition, there is a Blood Bank. In short, all the arteries of the Medical Sciences are running here. In recent years, the sharp dividing lines between the various branches of science are gradually shading out and, the specialist must now cease to work in "splendid isolation"; he needs the help from other sciences. This is especially true of the research worker in the field of medicine. For example, Immunology is slowly getting into the folds of Chemistry; the production of vaccines and sera, instead of remaining immutable as a bacteriological art, is becoming a technology; for a theory of formation of nerve fibres, ideas from astrophysics (!) are invoked; statistics is, of course, the handmaid of medical sciences. So, with the various interrelated departments organised at the Haffkine Institute, the researchers here can easily understand each others' language. Another gratifying feature consists in the provision of facilities for the large-scale production of drugs, a circumstance which rarely obtains at other research centres in this country. The Annual Report of the Haffkine Institute for the years 1942 and 1943 which has just reached us, gives an account of the various activities.

In the budgetary turnover of the Institute, we find that in the financial years 1941-42 and 1942-1943, the total expenditure incurred is respectively Rs. 456,430 and Rs. 7,09,701 against which it has realised Rs. 5,85,705 and Rs. 6,75,496 respectively by the sales of vaccines, sera, etc. The prices of the products from the Institute have remained competitive.

The Institute has as one of its primary duties the manufacture and supply of the medical requirements of the Governments. In the two years 1942 and 1943, the Institute has supplied 6,561,441 c.c. of plague vaccine, 6,724,243 c.c. of cholera vaccine, 336,799 c.c. of T.A.B. vaccine and 2,505 c.c. of meningococcal vaccine. The recently started Serum Department, though it has not yet reached its peak activity, has already made good progress. It maintains about 150 horses under immunisation and produces tetanus, gas-gangrene and diphtheria antitoxins, and anti-dysentery, anti-plague, and antisnake venom sera, totalling 3,39.355 ampoules in the two years. The tetanus welchii, septique, œdematiens, diphtheria, dysentery (Shiga) toxins have been produced. 220 Litres of tetanus toxoid were prepared, conforming to the accepted international standards. The Anti-rabic Department has treated 7,818 cases in two years and has prepared and supplied a total of 15,947 doses of anti-rabic vaccine. The Pharmacology Department has assayed 2,600 samples in the two years; it has supplied 15,000 sulphonamide paste tubes and 8,000 occlusive dressings to the army and 3,500 litres of glucose saline to the various organisations. The Chemotherapy Department has prepared the sulphathiazole required for clinical trials in plague and has supplied an antiseptic solution to the various hospitals.

The Pathology and Biochemical sections have rendered very valuable diagnostic aid to the various hospitals and to private practitioners; nearly 30,000 specimens were examined in the two years. As a caretaker of the health of the City and Province, the Institute does diagnostic work at a very moderate cost and free diagnosis is given to all practitioners in cases of infectious diseases as diphtheria, dysentery, cerebrospinal fever, enteric fever, typhus fever, cholera and malaria.

Haffkine Institute claims the distinction of being the first in India to obtain dried blood plasma with a locally fabricated plant. The Blood Bank has processed and dried 325·59 litres of human blood plasma in the two years.

In addition to this overburdened work due to production and routine, the research activity has been maintained at a high level. There are listed in the report 23 research publications and there is also given a brief account of the research covering 22 pages. The preventive and curative aspects of bubonic plague remain the special field of research activity of this Institute. A new plague vaccine, better than the old one, has been developed. The work of the Institute on the treatment of plague with the sulfa drugs is now widely recognised. New processes for the manufacture of some important sulfa drugs, which are covered by six patents, have been evolved and new compounds of this group have been synthesised. The pharmacology of these drugs and their effects in plague, war wounds and malaria, have been investigated. The production and preservation of anti-toxins and sera have been studied as also the changes in the protein fractions of plasma of horses undergoing hyperimmunisation against tetanus. Improvements in the methods of diagnosis have been made.

This Institute also serves as training centre for the health personnel and bacteriologists. During these two years 24 Chinese doctors and 6 local public health workers received training.

In nurturing a scientific institution one item requiring great foresight and careful consideration is the continuous replenishment and modernisation of the equipment. The problems that are presented to the researchers today demand for their speedy and satisfactory solution, special instruments and apparatus, the precision and accuracy of which are being improved almost daily. This has been well appreciated by Col. Sokhey whose constant

* "Report of the Haffkine Institute for the years 1942 and 1943," by Lt.-Col. S. S. Sokhey, I.M.S., Director, 1945.

endeavour has been to furnish the Haffkine Institute with the most modern and up-to-date equipment.

The chief problems of India are poverty and pestilence. If we have to have our public health problems tackled in an effective way, each Province should organise at least one Institution; it is revealed that Russia, which has tackled her public health problems in an admirable way, has 200 Medical Research Institutions. How many India shall need can easily gauged.

SOME ABNORMAL POLLEN GRAINS OF *PINUS EXCELSA* WALL.

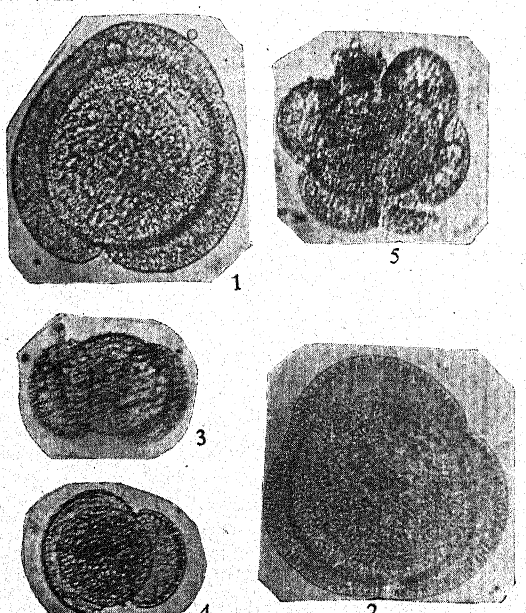
BY G. S. PURI, PH.D.

(Department of Botany and Geology, University of Lucknow)

INTRODUCTION

POLLEN grains of *Pinus excelsa* Wall., as also those of other members of the Abietineæ, are normally two-winged. However, abnormal pollen grains—with one wing (encircling the body like a frill), three wings or four wings—have been infrequently observed among normal pollen of both modern and fossil material of *Pinus* and in some modern species of *Cedrus* and *Abies*. Such abnormalities are by no means confined to the Abietineæ but they are recorded in other tribes also, *e.g.*, in the Podocarpineæ the number of wings is very variable and abnormal grains have been observed in more than one species of *Podocarpus*.

One-winged pollen grains with a single bladdery exine encircling the body like a frill are recorded by Wodehouse (10, p. 266, pl. 3, fig. 8) in *Abies nobilis* and similar grains have been observed in *Cedrus Deodara*, *Podocarpus neriifolia* (1, pl. 5, fig. 11; and pl. 13, fig. 19) and in at least one other species of *Podocarpus* (10, pp. 219, 274). Florin (2, p. 639, text-figs.



4*c*, *d* and *e*) has figured two one-winged pollen grains of *P. silvestris* from postglacial deposits of Sweden and according to him "Eneröth has found that among 38,887 subfossil pollen grains of *P. silvestris* collected in the Swedish province of Norrbotten 0·04 per cent. exhibited an abnormal number (1, 3 or 4) or extension of the air sacs".

Three-winged pollen grains are recorded in more than one species of *Pinus*. Florin (2, p. 639) has recorded from the post-glacial deposits of Sweden a number of three-winged pollen grains of *P. silvestris*, and similar abnormal grains of *P. Banksiana*, *P. Strobus* or *P. resinosa* have been figured by Wilson and Webster (9, pl. 2, figs. 21, 22) from Vilas County bogs in the U.S.A., which are of Pleistocene age.

In modern material of *P. Khasya*, *P. longifolia*, and *P. Merkusii* Miss *Chatterjee* (1, pl. 14, figs. 20-22) has observed three-winged pollen grains. Four-winged pollen grains have been found in *P. silvestris* (2, *loc. cit.*), *P. Banksiana* (?), *P. strobus* or *P. resinosa* (9, figs. 25, 26).

Although abnormal pollen grains with one or four wings are already reported in other species of *Pinus*, so far as the author is aware they have not been previously observed in *Pinus excelsa*.

DESCRIPTION

Fig. 1 is a photomicrograph of a one-winged pollen grain, which measures 76·5 μ in diameter. The bladdery exine, which encircles the body in the form of a frill, shows a strong tendency to get transformed into two wings. Another abnormal pollen grain, illustrated in Fig. 2, shows two notches and in this specimen a tendency to get transformed into three wings is clearly seen.

Fig. 4 is a photomicrograph of another abnormal pollen in which the two bladders are of unequal size (*cf.* fig. 3, a normal pollen grain) and similar pollen grains seem to be fairly common in this species.

A four-winged pollen grain is illustrated in Fig. 5. In this specimen the four bladders are symmetrically arranged round a body, which measures 54 μ in diameter.

DISCUSSION

It is interesting to note that a single bladdery exine, which is evidently an abnormality in modern and Pleistocene conifers, is a normal feature in ancient member of this group.

Some Palæozoic members of the Coniferales, *e.g.*, *Walchia*, *Lebachia* and *Ernestiodendron* (3) possessed one-winged pollen grains which do not seem to be very different from what we have described above. Pollen grains of Cordaitales were also one-winged and in

Spencerites insignis Scott (7, p. 170, figs. 78A, B and 84) and *S. membranaceous* Kubart (4, photo. 3), (ancient lycopodiaceous plants), though the pollen grains were much larger they bear a striking resemblance in external morphology to our one-winged pollen grains. In the light of the above facts one may reasonably ask: Is this abnormality merely a monstrosity of no genetical importance or is the occurrence of one-winged pollen grains in modern and Pleistocene conifers and in the Podocarpineæ a reversion to an ancient character normally found in Palæozoic conifers? An appropriate answer to this question is furnished by Florin (2, pp. 638-39), who states that "it seems probable that the presence of air-sacs in certain modern genera of the families, Pinaceæ and Podocarpaceæ, is a surviving ancient characteristic. The single air-sac originally present has only been slightly reduced since Palæozoic times, different in different genera". Wodehouse (10, pp. 219-21) agrees with Florin and states that "grains with this single encircling wing were common in the Palæozoic and appear to have been the prototypes of the winged-grained Abietineæ and Podocarpineæ".

Florin (2) further suggests that "this primitive type of pollen grain probably disappeared and the single encircling air-sac was replaced by two smaller sacs resembling those of the recent conifers of the families mentioned above". From the examination of our abnormal pollen grains it is easy to conceive how a one-winged pollen grain would have got transformed into a two-winged (fig. 1) and a three-winged type (fig. 2). Mehta (5), while supporting Virkki's (8) way of reasoning suggested that the one-winged spore could also have been the forerunner of a three-winged type and quoted Wodehouse and Florin in support of his arguments. From the present evidence it is suggested that a four-winged pollen grain may have also derived from a one-winged grain in the same way.

In the end I wish to thank Professor B. Sahni, SC.D., F.R.S., for kind suggestions and helpful criticism of this note. I am further grateful to him for kindly allowing me to examine the thesis of Mrs. Jacob (formerly Miss C. Virkki) and Miss Chatterjee and use the unpublished information in this note.

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OBITUARY

DR. HARPRASAD CHAUDHURY, Ph.D., D.Sc. (London), D.I.C.

CURRENT SCIENCE deeply regrets to record the sad and premature demise on 19th August last of Dr. Harprasad Chaudhuri, Head of the Department of University Teaching in Botany, and Director, Kashyap Research Laboratory, Punjab University.

Professor Chaudhuri was born in Calcutta in 1895 and had his school and college education in his native province of Bengal. He graduated from the Calcutta University in 1916 obtaining a distinction in Science. He took his Master's degree in Botany in 1918, and started research having been awarded a Research Scholarship in Botany. In 1920 he went abroad for higher studies and worked for three years as a research scholar under Professor V. H. Blackman, F.R.S., at the Imperial College of Science and Technology in London. After obtaining his PH.D. and D.I.C., he returned to India and was appointed Reader in Botany at the Panjab University. On the death of Professor S. R. Kashyap in 1934 Professor Chaudhuri succeeded him as Professor of Botany which post he held until his death. In 1939 he was admitted to the D.Sc. degree of the London University. Professor Chaudhuri was the first Director of the Kashyap Research Laboratory—an institution founded by public donation to perpetuate the memory of Professor Shiv Ram Kashyap.

Professor Chaudhuri displayed his interest in Mycological research early in his career. On his return from Europe he built up a school of Mycological research in the Panjab University which had already become a centre of research in Bryology under the inspiring guidance of Professor S. R. Kashyap. Professor Chaudhuri's own contributions have enriched the field of Indian Mycology and plant pathology which were his special fields of research. Although essentially a specialist in

Fungi his interests were wide and varied and his publications cover not only his study of some individual genera of fungi like *Meliola*, *Verticillium*, *Collectotrichum*, *Rhinosporidium*, *Paradiplodia*, *Haplosporella*, etc., but also his observation on the coralline roots of *Cycas* and *Zamia*, the haustorium in *Cuscuta*, mycorrhiza of forest trees and the endophytic fungi in Indian liverworts. He studied the phenomenon of Saltation in *Colletotrichum biologicum* sp. nov. He published a number of papers in the "Molds of the Punjab" and was recently engaged in a study of the Smuts of the Punjab. His report on the "Citrus diseases of the Punjab" embodies the results of a five years' scheme sponsored and financed by the I.C.A.R. He has recorded in this report his observations of the various aspects of the diseases like *wither-tip*, *chlorosis*, *sooty moulds*, etc., and suggested remedial measures. According to him the *wither-tip* disease of the fruit is caused by the fungus *Collectotrichum glœosporioides* and the 'sooty mould' covering the leaves and fruits brought about by a number of saprophytic fungi like *Acrothecium lunatum* Wak., *Capnodium citri* Berk. *et* Desm., *Alternaria citri* Pierce, *Cladosporium herbarum*, *Pleospora herbarum* Rab., *Chœtomium* sp., and *Aspergillus* sp. Chlorosis of the leaves on the other hand, is supposed to be more due to physiological causes than due to fungal attacks. In 1936 he suggested a scheme for enlightening the people of the country on the nature and causes of plant diseases and the methods of controlling and eradicating them. He and his collaborators have in several publications enhanced our knowledge of soil, fungi, mycorrhiza, bacterial and fungal diseases of plants and the physiology and ecology of fungi. As director of the Kashyap Research Laboratory he guided research in various branches of Botany, like Cytology, Bryology, Bacteriology and Morphology. In collaboration with Sir John Farmer he published for use in Indian Universities a book entitled *A Practical Introduction to the Study of Indian Botany!*

Professor Chaudhuri was a familiar figure at almost all the sessions of the Indian Science Congress which he regularly attended—often with his contingent of students. He presided over the Botany Section of the Indian Science Congress in 1932 and was the President of the Indian Botanical Society in 1941. He was a foundation member of the National Institute of Sciences of India. He represented India at the Twelfth International Horticultural Congress at Berlin in 1938 and presided over the Tropical Section at the same Congress.

A man of active habits and a lover of outdoor life, Professor Chaudhuri was immensely fond of field botany and organised long excursions into the Himalayan regions and conducted regular classes there during the summer months.

He was free and outspoken in his expression and was genial by temperament. He was popular amongst his friends, colleagues and students. He was married in 1919 and was fifty at the time of his death. His premature demise has deprived India of one of her leading Mycologists and an able professor.

A. R. R.

SATYENDRA NATH CHAKRAVARTI

D.Phil. (Oxon.), D.Sc. (Oxon.), F.I.C., F.A.Sc., F.N.I.

THE news of the sudden death of Dr. S. N. Chakravarti at the age of forty-five under tragic circumstances has come as a shock to his students, colleagues and friends. It is indeed a cruel irony of fate that this sincere and honest scientist with high ideals and full of ambition should be pitted against circumstances from which he could think of escaping only by nipping his thin-spun life. "The paths of glory lead but to the grave."

After a brilliant school and college record, Dr. Chakravarti went to Oxford to work in the Dyson Perrins Laboratory under the late Professor W. H. Perkin Jr. as his only Indian student. After working there for two years, he took his D.Phil. degree and returned to India in 1929 as the Reader in Chemistry and the Head of the Chemistry Department of the newly started Annamalai University at Annamalainagar. After serving this University for about seven years, he left this, much to the regret of his students and colleagues, to accept the post of the Chemical Examiner to the Government of C.P. and U.P., which he held till the time of his death.

Dr. Chakravarti was indeed an ideal teacher and his lectures, which were prepared with meticulous care and unusual sincerity, were the highlights of the Department. He had high ideals and believed that education does not consist in telling the pupils what they do not know but in making them what they were not. Since he was a born teacher, everybody who knew him regretted when he took up the post of the Chemical Examiner wherein he had to deal more with files and red tape than with flasks and chemicals and science journals.

Dr. Chakravarti was very keenly interested in research but he could not execute his plans to his full satisfaction at the University. His work includes the synthesis of a number of derivatives of tetrahydroprotoberberine, paraberine, pseudo-opianic acid, hydroxy derivatives of naphthalene, etc., and the chemical investigation of Indian Medicinal Plants. From Agra came forth papers which dealt with the methods used in the medico-legal and forensic work.

Dr. Chakravarti was a perfect gentleman in every sense of the term. He was an extremly kind and sincere man. India is badly in need of inspiring teachers like Dr. Chakravarti; yet because of strange circumstances which which are special to this country, he was driven to seek a job which had little to do with teaching and which never suited his genius.

We offer our sympathies to his wife and children whom he leaves behind.

K. G.

ON CARPEL

By B. G. L. SWAMY

(*Basavangudi, Bangalore*)

THE picture reproduced is intended to portray the three outstanding theories of the nature of the Angiospermous flower in general and its carpel in particular.

Nearly a hundred years ago, the great German poet-philosopher, J. W. von Goethe, conceived the Angiospermous flower as a modification of vegetative branch; according to him, a simple vegetative leaf with its three main vascular traces lost its colour and shape, acquired a different character and function and ultimately resulted in the sepals and petals. A similar leaf got its laminal surface reduced, the two lateral edges developed fertility, which offered a base for lodging the male fertilizing element; these structures have come to be known as stamens. Another leaf situated towards the tip of the branch upfolded; its margins got fused and after attaining fertility bore ovules which lodged the female sexual element; this transfiguration was accompanied by an elongation of the leaf-tip which has become differentiated as style and stigma, so much so this organ becomes a carpel. If we visualise a drastic reduction of the internodes between these metamorphosed leaves, we arrive at a "flower". This concept has been depicted in the picture as a climber which shows the several stages of the metamorphosis of the vegetative leaves.

There is also a much modified interpretation of the carpel, sponsored by Miss Edith R. Saunders in nineteen-twenties. The "classical", "monorphic" concept of Goethe holds that every carpel is a metamorphosed structure of a *single* leaf; but, she visualises such a carpel as a sort of compound structure consisting of a "valve" carpel and a "consolidated" carpel; this view has come to be known as "polymorphic". Miss Saunders believes that carpel polymorphism is a universal feature (even in those instances where she herself accepted monomorphism on previous occasions). Suffice it to record that this view has not met with acceptance; it has been severely criticised from several standpoints some of the significant ones being, (1) it rests on false assumptions and misinterpretations of important anatomical evidence; (2) Miss Saunders has generalised too hastily and has extended her theory to all flowering plants; (3) her contention that her polymorphic theory helps to clarify satisfactorily the various points of floral structure and organisation has, on the contrary, brought unnecessary complications into the arena; (4) some of the points "explained" by her have been invented in strange and roundabout methods so much that they have been described as "fantastic".

The most unusual example of carpel polymorphism of Miss Saunders is the instance of the common groundnut. That a single nut is a single carpel lodging a couple of seeds is generally accepted; but she contends that the nut is composed of 10 to 12 carpels as revealed by a corresponding number of longitudinally running vascular strands in the wall of the ovary! In spite of overwhelming criticism, however, she is clinging to her theory tenaceously. She has caged herself in the groundnut shell, reinforced by 10 to 12 main bars, a creation of her own imagination. Enveloped in the darkness of that self-erected cage, she shuns light and keeps repeating her untenable theory over and over again as though repetition could compensate for the lack of inherent soundness.

Until nineteen-thirties Goethe's "classical" view was not questioned on fundamental grounds. Evidence based on an accumulation of fossil data and a new interpretation in their light led Prof. Hamshaw H. Thomas to the view that mere metamorphosis does not explain satisfactorily the transition from the vegetative leaf to a fertile organ bearing sexual element. "The Angiospermic flower is *not* the homologue of a vegetative bud". So, he found the progenitor of the modern carpel in a lower Jurassic plant group, the Caytoniales, which, according to Prof. Thomas, show interrelationships between the lower Pteridosperms and the higher Angiosperms. The stamens and carpels exist in Caytoniales as "branch systems"; the modern stamen owes its origin to a form, *Antholithus Arberi*, and the nearest approach to this condition is what we see to-day in the flower of buttercup, poplar and walnut. Fossils like *Caytonia* and *Gristhorpia* are presented by Prof. Thomas to depict the ancestral condition of the modern carpel. These bodies lodging ovules (also called "ovaries" by him) are arranged in pairs on a main axis; during evolution, reduction and fusion have played a great role, a transitional stage in this process being represented in a hypothetical form, in which the pairs of "ovaries" are reduced to a single pair and the main axis becomes stunted; side by side with this process, lateral fusion of the two "ovaries" of the pair was accomplished so much so the ovule-bearing margins lie side by side. A complete fusion of the "ovaries" with one another and that of fused ovaries with the reduced main axis, result in the ultimate expression of the modern carpel. In short, "sterilisation of structures originally fertile is much more likely to have taken place than the metamorphosis of leaf-like structures into reproductive organs".

There are certain serious objections to this view. Apart from those legitimately raised against Prof. Thomas' terminology like "palmate sporophyll", "ovaries", etc., the most important criticisms are, that the evidence is one-sided being largely taken from fossils; that certain observations on the nature of living forms do not lend support to his argument; that the chain is broken at very crucial points; and that convincing intermediate stages are not in evidence at present, so essential for an understanding of the transitions.

An entirely new and striking idea as to the nature of the flower has been put forward by Prof. MacLean Thompson since the nineteen-

twenties. The evidence which has enabled him to put forward this theory has been collected by a study of what he calls "Developmental Morphology". The most significant feature of this view is the total rejection of the very existence of floral entities as carpels and stamens. "His theory directs attention to the flower as potentially sporogeneous axis-bearing floral parts which are not distinct entities but local extensions of the torus". The lower part of the primeval axis is sterile and gives rise to enations like bracts, bractioles and sepals. The upper part is potentially sporogenous. Into this mass sterility penetrates and advances to such an extent as to find the climatic expression in the modern flower, in which fertility becomes confined to the anthers and the surface of the hollow invagination of the receptacle; at whatever point on this fertile surface there is an accumulation of favourable nutrition, ovules emerge out as protuberances. The entire phenomenon of the "state of flowering known as Angiospermy" is thus explained purely on the basis of the principles of growth-physiology. Thus go rejected *in toto* all the current lines of speculation and the very notion of a carpel. According to Prof. Thompson, there is nothing like a carpel in the flower and the flower is "*Acarpous*". The "highlights" in this idea are depicted by the artist in "FUTURISTIC" manner and a human skeleton holds out a mirror in which carpel is seen only as an illusionary reflection.

This theory of "Acarpy" is, at first thought full of vigour, colour and attraction. But the most serious flaw is the gross rejection of the vascular structure indispensable to any morphological interpretation. In a limited sense the vascular structure may not be of much value. However, it does contribute towards an understanding of the "broader trends of race history". Prof. Thompson's views remain unacceptable because of its complete neglect of anatomical data, whose continued role in the verification of our morphological and phylogenetical interpretations are widely recognised.

Although most of the data on hand, developmental and anatomical, are in complete agreement with the "classical" theory, the theory is still imperfect. The Goethean view is regarded by some critics as nothing more than an instrument of description. They find it difficult to explain the derivation of a fertile organ from a sterile vegetative leaf, purely on the phenomenon of metamorphosis.* There is of course, a need for a much more cogent and comprehensive theory, which must be the outcome of a new approach. Saunders, Thomas and Thompson have certainly served us as pioneers in cutting fresh paths of enquiry and have undoubtedly given a new impetus to the study of a problem which was long neglected.

A critical appraisal of the different concepts leads us to the fact that the "classical" view of the flower in general and of its carpel in particular still remains unchallenged, and remains as firm and as solid as the statue of Gomateshwara. This statue at Sravanabelagola in the State of Mysore is a historical monolithic figure of colossal size, standing in the open, withstanding all environmental in-

fluences for the last 1,000 years. Even according to Jaina *puranas*, Gomateshwara is a symbol cf dignified solemnity. It is said that having renounced the world and its cares, Gomateshwara, the Jain prince, sought peace in the contemplation of the Eternal Truth. He lost all sense of the external world and became so completely absorbed within himself that snakes crawled about his person; anthills enveloped his limbs; and climbing plants twined round his body. These are also chiselled in the great statue. The artist here has made the "classical climber" of Goethe twine round his body.

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* Many botanists have, however, expressed the opinion that Goethe used the word "metamorphosis" in a figurative and not in a literal sense.

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LETTERS TO THE EDITOR

OCCURRENCE OF SUMMER DUST OVER DELHI

CONSIDERABLE amounts of dust are transported and deposited over Delhi and the neighbourhood during summer by the wind blowing from western or south-western direction. Wind-borne dust appears in the air from the last week of March and lasts till some portion of July when the monsoon rains start.

Collections of this wind-borne dust have been recognised to be fine soil characteristic of extreme arid zones[1] and in a way they represented the so-called dust soils near desert regions of America.[2] West and south-west of Delhi are the desert regions of the Punjab and the Rajputana. Summer winds of the west may be transporting the fine soil from these regions to deposit them over the more moist regions of Delhi and the neighbourhood.

As a result of these dust showers of summer, the nature of the soil in the neighbourhood of Delhi is bound to be affected. A casual observer will often come across the wind-borne deposits on bare tops of the ridges increasing annually in volume till they start growing vegetation. Needless to say that in composition they bear no relationship either to the adjacent rocky material or to the soil below. Delhi soil does exhibit some characteristics of wind-borne or æolian mixed soils. These are the absence of any striation in the soil and the abundance of kankar nodules at plant root depths.

It is probably now certain[3,4,5,6] that the salt sand and the kankar of the great Thar deserts were brought in by the south-western wind from the sea-shore round about the Ran of Cutch. Spread of alkali salts by wind in U.P. is also known.[7] From the great soil transporting power of the wind, which has been estimated by Prof. Udden[8,9] in America to be several hundred times that of a river, it will be evident that wind is an important agent in soil formation. This is specially true for semi-arid regions, like Delhi where rivers controlled by specific geographical conditions, have long ceased to have any influence on the predominating changes occurring in the soil.

Total deposit during summer over Delhi is of considerable volume. If the figure for a deposit volume during 1942 (*loc. cit.*) is taken, it can be calculated from the number of dusty days as detailed in this article, that a deposit of one inch thick occurs in every seven years. Taking various other considerations of re-transport from drier regions a fair estimate for each inch of thickness of deposit is approximately ten years.

During the summer of 1942, wind-borne deposits were collected during dust storms and analysed for different mechanical fractions. There seemed to be not much difference in the composition between different deposits. Accurate collection of dust could not be continued due to several difficulties. A record of general weather conditions was, however, continued the days during which transported dust was felt in the air were marked as dusty. It is from the number of dusty days during each summer month from March to July that it is found that they could be correlated to a cer-

tain extent with other simple meteorological factors such as temperature, wind velocity, humidity and rainfall. The present is a record of the observations kept for four years, 1940-43.

The following table contains the averages of some meteorological factors and the number of dusty days for the period 1940-43:—

Month	Rainfall in inches	Humidity%	Temp. °F.	Wind Velocity in miles per hour	No. of Dusty Days
January	1·0	78	49	5·9	..
February	0·9	65	55	7·2	..
March	0·1	43	68	8·5	4
April	0·3	30	80	8·7	9
May	0·3	29	89	10·2	19
June	1·7	49	89	9·4	12
July	6·2	73	87	10·2	5
August	8·2	83	83	9·5	..
September	3·1	73	80	7·7	..
October	..	57	74	5·8	..
November	..	47	62	4·5	..
December	0·3	67	51	5·4	..

It appears that it is in the month of May the driest of the year, that the largest number of dust storms occur. This has also been found in Oklahama by Langham and others.[10] Kelogg[11] recorded similar observations.

It can be concluded that the number of dusty days in any summer month varies directly as the wind speed and the temperature and inversely as the humidity and rainfall.

From various considerations this is not altogether unexpected. Thus occurrence of dust in the air is intimately connected with meteorological conditions. Driest and warmest years are expected to have dustiest summers and this is probably true for all localities situated in arid and semi-arid regions.

Imperial Agric. Res. Institute,
New Delhi, ABHISWAR SEN.
August 7, 1945.

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A RELATION BETWEEN THE SHEAR CONSTANT c_{44}, MELTING POINT AND INTERATOMIC DISTANCE OF METALS

IT is usual, in the study of the solid state of matter, to correlate the various physical properties of solids to their lattice constants and obtain the latter independently from them. A similar study reveals that the shear constant c_{44} of all metals crystallising in the cubic system is intimately related to their melting-points and the interatomic distances. It is found that the following relation holds good:

$$\frac{(c_{44})_0 r^3}{T_m} = 9 \cdot 0 \times 10^{-15}$$

$(c_{44})_0$ is the shear constant of single crystals at the absolute zero, r is the interatomic distance and T is the melting-point in degrees Kelvin. The interatomic distance calculated from the above formula on substituting the known values of c_{44} and T_m are given in the table. With the exception of αFe, c_{44} for all the metals have been taken from our earlier paper[1] where their values at the absolute zero were estimated. The room temperature values have been used for W, Pb and αFe. On account of the small coefficient of expansion of tungsten, we do not expect a large difference between the room temprature and the absolute zero values of c_{44} in that case, but in the other two cases the difference may be of the order of 10 per cent. The errors of measurement of c_{44} are, however, generally larger. It will be seen that the difference between the calculated and experimental values of r is never more than 5 per cent., which is of the order expected from the uncertainty of about 15 per cent. in the values of $(c_{44})_0$.

It is interesting that a change from the face-centered to the body-centered structures does not effect the validity of the formula.

Structure	Metal	$r \times 10^8$ calculated	$r \times 10^8$ experimental
Face-centered ..	Al	2·96	2·86
	Ag	2·82	2·86
	Au	2·89	2·87
	Cu	2·46	2·55
	Pb	3·35	3·49
Body-centered ..	W	2·78	2·73
	αFe	2·41	2·47
	Li	3·14	3·04
	Na	3·78	3·72
	K	8·87	4·62

BISHESHWAR DAYAL.
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September 9, 1945.

1. Dayal, *Proc. Ind. Acad. Sc*, 1944, **A**, **20**, 24.

A NEW HYPOTHESIS FOR THE MECHANISM OF ACTIVATION OF SUBSTRATE MOLECULES BY ENZYMES

ACTIVATION of molecules in chemical processes is very generally accepted to be due to collision between reactant molecules with sufficient violence, resulting in transformation of kinetic energy of translation into vibrational energy

within the molecule. Enzymes, however, are peculiar in bringing about reactions at much lower temperatures and hence must be assumed to have acted according to one or other of the two following mechanisms:

(*i*) By making the reaction follow some different path, which entails much less energy consumption; an intermediate complex of enzyme substrate is formed which can then break into the reaction products liberating the enzyme again.

(*ii*) By supplying energy[1] to the system of reacting molecules necessary for their activation; Medwedew[1] has rejected the intermediate complex mechanism and proposed one in which the molecules of the enzyme can activate the substrate molecules according to the following scheme:—

(*a*) $F + h\nu \longleftrightarrow F^*$

(*b*) $S + h\nu \longleftrightarrow S^*$

(*c*) $S^* \longrightarrow R^* + P$

(*d*) $R^* \longrightarrow F^* + R$

F (enzyme molecules) become activated (F^*) by taking a quantum from the energy liberated in decomposition. F^* collides with the substrate S and activates them to S^*. R and P are products of decomposition.

The following facts are, however, clear from both the theories:—

(*i*) The outstanding property of enzymes, *viz.*, their specificity has not been adequately explained. Theory of active groups and centres when reviewed critically degenerates into something like arguing in a circle (*cf.* Bayliss[2]).

(*ii*) The enzymes are known not to contain any other group than the ordinary proteins; why not then all the proteins are catalytically active?

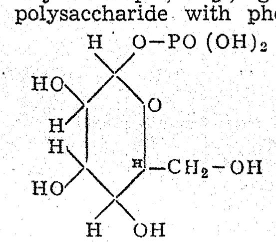
(*iii*) Even in any given reaction the view that substrate molecules have some definite active groups appears to be opposed by the observations of Munch and Kuhn[3] on sucrose inhibition.

The following mechanism for the activation of substrate molecules by the enzyme, is, therefore, proposed as a preliminary hypothesis. The enzyme molecules are unstable bodies at the ordinary temperature; due to this fact the enzyme molecules can give off energy, the transference of energy from the enzyme to the substrate molecules occurs by virtue of the (*i*) resonance between some group or atomic vibration in the substrate and some characteristic frequency in the enzyme molecule (primary activation). (This must occur prior to any enzyme-substrate complex formation, if any such compound formation occurs). A similar mechanism of resonance has been postulated to explain the high efficiency of exciting the lower vibrational states of ethylene by hydrogen.[4]

(*ii*) From this excited group or atom of the substrate molecule distribution of energy among the various other bonds may occur *under the influence of the enzyme*, so that energy may finally be stored in the bond which will be the seat of chemical reaction (secondary activation). Such redistribution of energy to other parts of the molecule from one particular bond which primarily receives energy is known to occur in the photo-chemical decomposition of ketene[5] and also in some prototropic changes.[5]

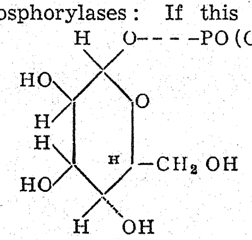
It has, however, been shown that activation by absorption of infra-red radiation is hardly possible; however great the energy density, the fundamental frequencies cannot decompose the molecule because the energy of the quantum is not large enough, and a harmonic having sufficiently high frequency is not absorbed.[6] It appears possible, however, that the energy required for the reaction may be absorbed not in a single quantum of certain frequency but in terms of several quanta at a correspondingly lower frequency.[7] A further possibility may be presented in a stepwise absorption of vibrational energy, the next step of absorption occurring only after excitation has died down by distribution of energy among other bonds.

The case in point may best be illustrated by one arbitrary example, *e.g.*, glucose-1-phosphate → polysaccharide with phosphorylases.



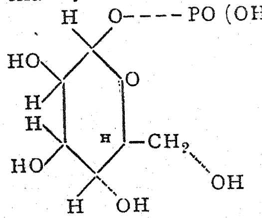
(*i*) The etheric oxygen atom is set into resonance vibration by the enzyme, (*ii*) part of the excess energy goes over to the upper part of the molecule and is located in O — P bond while the rest flows down the lower part, one fraction exciting the C_6 — OH bond while the other is located in the C_4 — OH bond. For steric reasons the C_2 — OH bond cannot become chemically reactive by absorption of energy.

Depending on the nature of the phosphorylases, a relative distribution of energy between the C_6 — OH bond and C_4 — OH bond occurs, in the case of plant phosphorylases the former is very little excited, practically the whole share going to the latter, while an *almost* equitable partition of energy between the two bonds occur in the case of animal phosphorylases. The result can be shown thus: (*i*) For plant phosphorylases: If this now condenses



with itself with elimination of phosphoric acid, starch will result (*i.e.*, glucose 1 : 4 glucoside chains) and for the second case: (*ii*) for animal phosphorylases: Condensation of this with itself will give rise to branched chain carbohydrates in which some are glucose—1 ; 4-

glucoside chains and others are glucose—1 :6-glucoside chains, the relative excitation of



C_6—OH and C_4—OH bonds determine unit chain length, *i.e.*, whether glycogen or amylopectin will be formed. Hence animal and plant phosphorylases would appear to differ only in degree and not fundamentally in their mode of action. Since monomolecular decomposition occurs by virtue of a "time-lag" between activation and decomposition due to redistribution of energy among the various degrees of freedom, such a system as above will be expected to decompose unimolecularly.

Let us now review some of the enzymic properties in the light of the above hypothesis.

Specificity.—Specificity of enzymes is determined by the fact that approximate coincidence or 'matching' between the characteristic frequency of the enzyme and that of some group, etc., of the substrate molecule must occur. Since it is known that frequency of a group may remain more or less unchanged or unaffected by other parts of the molecule, it is no wonder that compounds with similar structure should be the substrate for the same enzyme.

Inhibition.—(*i*) Competitive type: this occurs when the primary activation, *viz.*, resonance of the inhibitor molecule with the enzyme molecule can occur but the second step, *viz.*, distribution and localisation of energy in some suitable part of the inhibitor molecule, which may react chemically is not possible. Hence this type of inhibition occurs only with molecules which are chemically related to the substrate.

(*ii*) Non-competitive type: When the inhibitor molecule may react with the substrate molecule or enzyme molecules so that they become "out of tune", activation is inhibited and the reaction retarded.

Energy of activation.—It is generally found that the heat of activation is smaller for the enzymic decomposition of any chemical compound than the non-catalysed process. It is evident that in thermal activation, all parts of the molecule must be raised to a high level so that a particular bond which is to break may have a definite amount of vibrational energy; but in the enzymic process the enzyme can by its influence cause the energy to be specifically located in the said bond and thus can dispense with the extra amount of energy which goes to other parts of the molecule. It follows from our present scheme that when the primary absorption of energy occurs at a bond which is also the seat of chemical reaction, the heat of activation will be expected to be a minimum; but when this is not the case, *i.e.*, when the second phase of activation, *viz.*, localisation of energy in some other bond is required naturally the heat of activation will be expected to be greater.

Effect of a slight change in substrate or enzyme.—A slight change in substrate may serve to make it in better harmony with the enzyme, *e.g.*, native egg albumin is slowly hydrolysed by trypsin, but slight heating of the solution makes it very susceptible to attack by the enzyme. For the similar case of trypsin on keratin it is known that the appearance of —SH groups is not responsible for the observed phenomenon. Activators of enzymes may also be effective in the same way.

In this connection a closer study of (*i*) coupled reactions such as xanthine oxidase + xanthine + catalase + ethyl alcohol; (*ii*) action of mixture of two enzymes on the same substrate, *e.g.*, Haworth's 'Q' factor and Hanes' potato phosphorylase on glucose-1-phosphate; (*iii*) change of the nature of reaction with the same enzyme under different experimental conditions, *e.g.*, muscle phosphorylase *in vitro* and *in vivo*; (*iv*) reactions in which one enzyme catalyses the direct side and another (and a quite different one) catalyses the reverse, will be of interest. According to our present conception, specificity being determined by some frequency in the enzyme molecule, may be susceptible to change under different experimental conditions and is not rigid depending upon some unchangeable active groups.

The real test of a hypothesis lies, however, in its quantitative aspect; but since the infra-red and Raman data on complex molecules are meagre and since the interaction of the various energy states in the complex molecule is difficult to anticipate, a full mathematical treatment is not easy.

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May 1, 1945.

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CUPRIC-AMMINO-SULPHATES

A. K. DEY and A. K. Bhattacharya[1] have reported evidence from the electrical conductivity measurements of the existence of cupric-amino-sulphates having 2, 4, 5 and 6 molecules of ammonia for a molecule of copper sulphate. In another publication[2] these authors report that they have succeeded in isolating a blue amino-copper sulphate having five molecules of ammonia for one molecule of copper sulphate. The existence of the aforesaid amino-compounds and of others having intermediate composition has been concluded by previous workers from a systematic study of some physical properties of copper sulphate and ammonium hydroxide system. Bhattacharya and

Dey have observed the existence of a new compound containing six molecules of ammonia.

These amino-compounds are formed by the addition of ammonium hydroxide to a solution of copper sulphate. If this addition is done gradually, a precipitate first comes down; with further addition of ammonia it goes into solution developing an intense blue colour. A study of the absorption spectra of this solution by Bhatnagar, Goyle and Prasad has shown that the main blue colour is more or less identical in nature when various concentrations of ammonia are used. This would not happen if definite compounds of different compositions are formed, that is, cupric-ammonium sulphates containing ammonia in definite different proportions do actually exist. Bhatnagar, Goyle and Prasad[3] have shown that the absorption band obtained with the intensely blue-coloured solution formed by the addition of ammonia to copper sulphate is identical with that obtained with a suitably prepared colloidal solution of copper hydroxide. These observations would lead to the conclusion that the variety of the copper ammonia compounds obtained by Bhattacharya and Dey and other workers are adsorption complexes, containing different proportions of ammonia, formed by the peptising action of ammonium hydroxide or ammonium salts on copper hydroxide.

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Mata Prasad.

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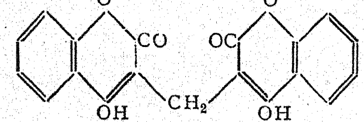
September 13, 1945.

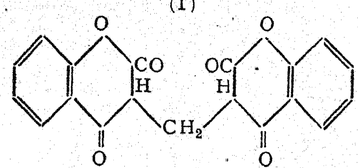
1. *Curr. Sci.*, 1945, **14**, 69. 2. *Ibid.*, 1945, **14**, 201. 3. *Koll. Zeit.*, 1928, **44**, 79.

ON "DICOUMARIN"—SYNTHETIC ANTI-COAGULANT

In search for the causative agent of the hæmorrhagic disease of cattle on feeding spoiled sweet clover hay, it was noticed that 3, 3[1]-methylene-bis-(4-hydroxy) coumarin (I) is the substance that is acting as an anti-coagulant. It has since been synthesized from 4-hydroxy coumarin and is being suggested as an effective agent in post-operative thrombophlebitis, puerperal thrombosis, and pulmonary embolism.



(I)



(II)

It is of interest to note that this naturally occurring coumarin in sweet clover hay is acting as an anti-coagulant whereas other coumarins from *E. Ayapana* are known (*cf.* Dymock *et al.*,[2] and Bose and Ray[3]) to act as coagulants. The above coumarin derivative (I)—also commercially known as "Dicoumarin", possesses no *in vitro* activity whereas the well-known anti-coagulant, heparin, is active both in *in vivo* and *in vitro*. Does it indicate that "Dicoumarin" is not a coumarin but a chromone of the structure (II)? Link and his collaborators[4] have published a series of papers on the chemistry of 4-hydroxy coumarin from which this "Dicoumarin" is being produced synthetically. But the formation of its salts, its reaction with bromine, behaviour towards alcoholic ferric chloride and certain ketonic reagents, condensation with compounds containing active methylene group and many other reactions, indicate the non-existence of a hydroxy group in these 4-hydroxy coumarins. This, in other words, indicates that the compound may also exist in the form (II) when it becomes a 2-keto chromone derivative and as such may differ physiologically from the other natural coumarins as isolated from *E. Ayapana*. Details of the work are going to be published elsewhere.

Bengal Immunity Research Laboratory, Calcutta,
July 10, 1945.

S. P. Dhar.
U. P. Basu.

1. Cambell and Link, *J. Biol. Chem.*, 1941, **138**, 21. 2. Dymock *et al.*, *Pharm. Indica*, **2**, 245. 3. Bose and Ray, *J. Ind. Chem. Soc.*, 1936, **13**, 586. 4. Link *et al.*, *Jour. Amer. Chem. Soc.*, 1943, **65**, 2288 and subsequent papers.

A NOTE ON THE OCCURRENCE OF *ALCALIGENES RADIOBACTER* IN THE AERIAL ROOTS OF *PHOENIX SYLVESTRIS*

Palacios and Bari, in a previous article,[7] had reported the presence of a new organism in the nodules of *Cajanus indicus*. Since then Bergey[2] had also referred to it suggesting that the organism mentioned to by those workers may well be *Alcaligenes radiobacter*, despite the well-marked differences exhibited by the new species. The present workers too had an opportunity of isolating a new micro-organism from the aerial roots of *Phœnix sylvestris*, but in agreement with Bergey's opinion that no new organism should be labelled as new species (to avoid multiplication of the species), but should be, as far as possible, referred to as a variant of one of the existing species, the new organism has been named only as *Alcaligenes radiobacter*.

Phœnix sylvestris is a palm not yet adequately studied. d'Almeida and Correa[1] only recently have studied in detail the anatomy of this plant, and in agreement with the report of Kuster[5] in connection with *Phœnix rectinata*, these workers have also observed the presence of *yellowish brown contents* occurring in the cortical cells of *P. sylvestris*. Richter[8] con-

sidered these contents in *P. rectinata* as those of tannin, but the present authors observed (on microscopical examination) that the contents of *P. sylvestris* were motile. With a view to ascertain if these yellowish brown contents were living organisms, some of the aerial roots collected from different plants of *P. sylvestris* were inoculated on meat-infusion agar, Czapek agar, Congo-red media of Kellerman[4] and of Leonard[6] after that they had been treated by a mercuric chloride solution as recommended by Harrison and Barlow.[3] The plates on incubation revealed the growth of some colonies: yellow colonies were observed on meat-infusion agar; on Kellerman's medium the colonies (whitish) were practically not absorbing the dye; on Leonard's they were clearly coloured but were not typically looking like those of *A. radiobacter*; the Czapek agar gave rise to slimy white colonies like those of *Klebsiella pneumoniæ*.

The apparently different organisms isolated on these media were eventually proved to be one and the same species; the pigment appearing on meat-infusion agar was lost on Czapek for mucilage and *vice versa*. The micro-organism on routine cultural examination consistently revealed the following characteristics:—

Morphology: Rods, 0·54 to 0·75 by 1·13 to 1·41 microns, actively motile, peritrichically flagellated, non-capsulated, non-spore bearing and found in groups. Gram negative. *Infusion agar slant*: Abundant, slightly slimy, translucently greenish-yellow. *Agar colonies*: Minute, moist, raised, circular, greenish-yellow. *Czapek agar*: Abundant, slimy, white; no sign of yellow pigment. *Infusion broth*: Heavy, general turbidity, thin pellicle, mucoid deposit. *Peptone water*: Moderate, otherwise same as in the broth. *Potato*: Abundant, lemon-yellow to light red pigment. *Gelatine colonies*: Slimy, not well-pigmented; gelatine not liquefied. *Nitrates*: Reduced to nitrites. *Indol*: Not formed. *Hydrogen sulphide*: Not produced. *Sugar media*: No observable reaction; abundant growth in presence of mannite, glucose, lactose, dextrine and maltose, but not saccharose. *Starch*: Feebly hydrolysed. *Milk*: Strongly alkaline. *Pigment*: Slightly soluble in water, soluble in 95 per cent. alcohol, insoluble in chloroform, ether and carbon disulphide. *Carbohydrates agar*: Whitish colonies, very slimy instead of pigmented. Presumably mucilage prevents chromogenesis by cutting off the oxygen supply. *Carbohydrate-free agar*: Solidified peptone water proved to be a poor medium; meat-infusion agar (with sugars eliminated by *E. coli growth*) was the best for chromogenesis. *Adaptation Power*: Eight months' adaptation on infusion agar made it lose to a great extent its slime production on Czapek; the property was regained in serum-milk. *Optimum temperature*: 28° C. *Nitrogen fixation*: Slight power.

All the observations lead to the conclusion that this is a new species; but because of its occurrence in the endophytic state and of its resemblance to *A. radiobacter* (despite very many well marked differences) the authors are inclined to label this new species as a variant of *Alcaligenes radiobacter*.

SUMMARY

Presumably a new micro-organism, but labelled for convenience as a variant of *Alcaligenes radiobacter*, isolated from the aerial roots of *Phœnix sylvestris* is described at length.

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July 1945.

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F. FERNANDES.

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A PRELIMINARY NOTE ON THE ANTIBACTERIAL SUBSTANCE FROM *ASPERGILLUS FLAVUS*

WHITE (1940) first observed that *Aspergillus flavus* when grown on certain liquid medium yielded a filtrate that showed anti-bacterial activity against gram-positive and gram-negative bacteria. Glister (1941) obtained antibacterial concentrate from *Aspergillus flavus* but did not isolate it in a crystalline form. Bush and Goth cultivated *Aspergillus flavus* on the surface of the liquid medium and obtained an anti-bacterial substance. This substance which is soluble in ether and water was called Flavicin. It was extracted by the authors with isopropyl ether in an atmosphere of carbon dioxide. The crude product, toxic to mice, was found to be innocuous after purification. Waksman and Bougie (1943) used six strains of *Aspergillus flavus* and five of *Aspergillus flavus orizæ*, the latter yielding little or no anti-biotic substance. According to them two factors were responsible for the anti-biotic activity, namely, aspergillic acid, which is active both against gram-positive and gram-negative bacteria and flavicin mostly active against gram-positive bacteria and, therefore, very similar to penicillin. The strain of *Aspergillus flavus* under submerged condition of growth, produced enough flavicin to be compared favourably with penicillin produced by the best strain of *Penicilium notatum* grown under similar conditions. McKee and MacPhillany (1943) found from *A. flavus* antibacterial substance unlike aspergillic acid and closely resembling penicillin in its biological and chemical nature. Menzel *et al.* (1943) gave

detailed comments on anti-biotic substance elaborated by a strain of *Aspergillus flavus* and an unclassified mould. The authors fully explained the chemical nature of pure aspergillic acid in crystalline form which was tested against and staphylococci and other organisms in high dilutions. Jones *et al.* (1943) also found similar substance using the same strain of the fungus, but one of the variants showing Chlamydospores gave more potent antibacterial substance than others.

MATERIALS AND METHODS

A strain of *Aspergillus flavus* which was found to contaminate a flask of tomato juice and giving a zone of inhibition (25 mm.) against *Staphylococcus aureus* by cup-and-plate method was selected for the work. This fungus when grown on Difco Peptone-agar at pH 7·6 gave an inhibition zone of about 15 mm. (when the growth is 2 mm. in two days). The fungus when grown on Sauboraud's medium (glucose-agar) showed yellow spores at first, which gradually became green, changed to deep green and later dirty brown in colour.. The strain was maintained in Sauboraud's medium, but before inoculation it was cultivated in test-tubes containing bran sterilized by autoclaving. Yellow green spores developed in these tubes in three days when they were easily dispersible, and inoculated on the surface of the liquid medium. Cultivation of spores direct from Sauboraud's medium gave similar results.

Strains of *A. flavus* isolated from different sources, namely, bread, wheat, flour, fruits, etc., were found to give antibacterial substances in approximately same quantities when grown under similar conditions. All the cultures were maintained at the room temperature varying from 25° C. to 35° C. at Calcutta and no degenerative changes were noticed. A strain of *A. flavus orizæ* which was used for the routine production of Taka-diastase was tried for its antibacterial activity with respect to the development of antibacterial substance in different media described elsewhere. This did not produce any antibacterial substance whatsoever. Some of the strains when used to produce diastase were found to be as rich in diastase as any of the preserved strains of *Aspergillus flavus oryzæ*.

Various laboratory media were tried to find one that would give a maximum titre of antibiotic substance against *Staphylococcus aureus*. As a rule liquid media were used, but semi-solid medium containing ·5 per cent. agar gave

TABLE I

Serial No.	Medium	pH	Growth and sporulation	Maximum dilution of the filtrate in which antibacterial activity (a.a.) is marked against *Staphylo aureus.*
1	Doglas broth	7·6	Thin mat. Few spores 7th day.	1/40 dil.
2	Semi-solid agar	7·6	Thick white mat. Spores Nil.	1/80 dil.
3	Bacto-peptone 2%	6·7	Soft moist mat. Spores Nil.	1/10 dil.
3*a*	Bacto-peptone 2%	7·4	Soft moist mat. Spores Nil.	1/40 dil.
4	Bacto-peptone 2% & 2% cane sugar ..	6·7	Thin mat with green & then brown spores. Spores 3rd day.	No a.a. in 1/10 dil.
4*a*	Bacto-peptone 2% & 2% cane sugar ..	7·4	Thin mat with green & then brown spores. Spores 3rd day.	1/10 dil.
5	Bacto-peptone 2% & sod. acetate 1%	6·7	Thin moist mat. Spores Nil.	No a.a. in 1/10 dil.
5*a*	Bacto-peptone 2% & sod. acetate 1%	7·4	Thin moist mat. Spores Nil.	No a.a. in 1/10 dil.
6	Bacto-peptone 2% & 2% cane sugar & sod. acetate 1%	6·7	Thin moist mat. Spores 3rd day.	No a.a. in 1/10 dil.
6*a*	Bacto-peptone 2% & 2% cane sugar & sod. acetate 1%	7·4	Thin moist mat. Spores 3rd day.	1/10 dil.
7	Casein peptone 2%	6·7	Moist mat. Spores Nil.	1/10 dil.
7*a*	Casein peptone 2%	7·4	Moist mat. Spores Nil.	1/40 dil.
8	Casein peptone 2% & cane sugar 2%	6·7	Thick mat with moist areas on surface. Spores Nil.	1/10 dil.
8*a*	Casein peptone 2% & cane sugar 2%	7·4	Thick mat with moist areas on surface. Spores Nil.	1/50 dil.
9	Casein peptone 2% & sodium acetate 1%	6·7	Thick mat. Spores Nil.	1/50 dil.
9*a*	Casein peptone 2% & sodium acetate 1%	7·4	Thick mat. Spores Nil.	1/10 dil.
10	Casein peptone 2% & cane sugar 2% & sod. acetate 1%	6·7	Thick crumpled mat with dew drops like moist areas on the surface. Spores Nil.	1/10 dil.
10*a*	Casein peptone 2% & cane sugar 2% & sod. acetate 1%	7·4	Thick crumpled mat with dew drops like moist areas on the surface. Spores Nil.	1/80 dil.

very satisfactory results. Various modifications and combinations of Czapeck-dox synthetic media with and without cane-sugar and also in combination with steep water, yeast extract and peptone were tried without any encouraging result. At this stage it was found that nutrient agar which was prepared from trypsin-digested meat gave a good growth of the fungus at pH 7·6 without spore formation and showed inhibition against *Staphylococcus aureus.* So trypsin-digested broth was selected for further study of the fungus. The initial pH of the medium at which antibacterial activity was marked was between 7·4 to 7·6. Trials were conducted with casein-peptone (trypsin-digested), bacto-peptone with and without sucrose at pH 6·7 and 7·4. Sodium acetate was supplemented in similar series. The results of all these experiments are shown in Table I. From third day after the inoculation the antibacterial activity was observed and the maximum development of antibacterial substance was noticed between ninth and thirteenth day depending on the growth of the fungus mat.

The following characteristics may be pointed out regarding the development of the antibacterial substance:—

(1) Development of the antibacterial substance depends on the particular strain of the fungus.

(2) Formation of good mat is essential but without sporulation.

(3) Sporulation is harmful for the development of antibacterial substance.

(4) pH 7·4 gives a better result for development of antibacterial substance than a pH 6·7 or 6.

(5) In all cases antibacterial substance was found to develop between nine and thirteen days after inoculation of fungus depending on the quality of mat-formation.

(6) The final pH of the medium was found to be between 8·4 and 9 when the maximum antibacterial activity developed.

Concentration

An attempt was made to concentrate the filtrate containing the antibacterial substance and the following process was adopted.

The fungus-free filtrate which was slightly alkaline in reaction was treated with acetic acid till the pH was 3·5. This was then adsorbed by activated charcoal (about 2 per cent. W/V). (A second adsorption is necessary if the filtrate is not clear.) Charcoal was filtered after 3 hours when clear filtrate was recovered. The charcoal was dried on the filter-paper. The dry charcoal was then eluted with ether or chloroform and refluxed for 4-6 hours.

The elution was found to be incomplete with ether and, therefore, in later experiments it was eluted with chloroform. After the elution charcoal was filtered off and the clear dark orange coloured chloroform extract was evaporated to dryness.

The residue was treated with 2 per cent. sodium bicarbonate and tested for antibacterial substance. It was found that the total antibacterial unitage in the whole fluid could be approximately recovered. Further work on the isolation of the active principle is under progress.

The advantages of antibiotic substance from *Aspergillus flavus* in the tropics over penicillin obtained from *P. notatum* are manifold, important of which are:—

(1) The fungus is easily isolated from everyday contamination in the tropics.

(2) It requires no special method for the preservation of spores but in the case of *Penicillium notatum* a special method has to be followed to maintain spores to have maximum yield of penicillin.

(3) The cultures may be cultivated at the room temperature of the tropics varying from 25°-35° C. in a place like Calcutta and no special arrangement is necessary in an air-conditioned chamber for the regulation of temperature during incubation for the optimum yield of penicillin.

The Research Laboratory,
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Calcutta, N. C. Dey.
June 21, 1945.

1. White, *Science*, 1940, **92, 127.** 2. Waksman and Bougie, *Chem. Absto.*, 1943, 6301. 3. White and Hill *J. Bact.*, 1943, **45,** 433. 4. Glister, *Nature*, 1941 **148,** 470. 5. Jones, Helan, *et. al.*, *J. Bact.*, 1943, **45,** 461. 6. McKee and MacPhillany, *Ibid.*, 1943, July 1943.

STUDIES IN THE SULPHUR FORMATION AT KONA, MASULIPATAM—PART II

The isolation and general characteristics of *Vibro desulphuricans*, Konæ has previously[1] been demonstrated to be responsible for sulphate reduction in the sulphur areas at Kona. It was of interest to elucidate in greater detail the physical and physiological requirements of the organism for its growth and functioning.

1. *Temperature.*—The organism was inoculated in the stock medium and incubated under anaerobic conditions at various temperatures for 72 hours. The results are shown in Table I.

Table I

Temperature of incubation °C.	25	30	37	45
Blackening after ....days	5	3	No Blackening	No Blackening

2. *Thermostability.*—The culture, inoculated in the stock medium was subjected to different temperatures for measured periods; It was then immediately cooled under running tap water (temp. 25° C.) and thereafter incubated at 30° C. for 72 hours, and examined after this period. Table II gives the results.

TABLE II

Temperature °C.	55	60	60	70	75	80	80
Time of treatment in minutes	10	5	10	1	5	0·5	1
Reduction after 72 hours	+	+	nil	+	nil	+	nil

3. *Hydrogen-ion concentration.*—The organism is highly sensitive to changes of pH below 7·0. The capacity to grow and the function to reduce sulphates, were found to be abolished when the pH of the medium was slightly below 7·0 while the maximum pH tolerated was 8·5; the optimum pH was found to lie between 7·2 to 7·4.

4. *Oxygen requirements.*—The organism is a strict anaerobe and under aerobic conditions it has little effect on the sulphates. The culture tubes after inoculation are best maintained in a desiccator containing freshly prepared alkaline pyrogallol and evacuated by a filter pump.

5. *Salinity.*—The organism was inoculated in a basal medium (composition: sodium lactate 0·2 per cent., sodium sulphate 2·0 per cent., dipotassium hydrogen phosphate 0·2 per cent., ferrous ammonium sulphate 0·1 per cent. and ammonium sulphate 0·2 per cent.), containing increasing concentrations of sodium chloride. The cultures were incubated at 30° C. Results are shown in Table III.

It will be observed that optimum salinity for the organism is 6 per cent. and while the reduction can be effected in the absence of sodium chloride, the presence of as high a concentration as 13 per cent. does not affect the activity of the organisms.

6. *Sources of Nitrogen.*—A basal medium (composition: sodium chloride 6 per cent., sodium sulphate 4 per cent., sodium lactate 0·2 per cent., dipotassium hydrogen phosphate 0·2 per cent. and ferric chloride 0·1 per cent.) containing equivalent quantities of different forms of nitrogen (22 mgm. of nitrogen per 100 ml. medium) was inoculated with the culture and incubated at 30° C. The results are shown in Table IV.

It will be observed that organic sources of nitrogen as urea, casein hydrolysate and peptone are more rapidly metabolised than the inorganic forms. Nitrates and nitrites appear to be toxic to the organism.

7. *Sources of carbon.*—A basal medium (composition: ammonium sulphate 0·1 per cent., manganese sulphate 0·2 per cent., calcium sulphate 1·5 per cent., magnesium sulphate 0·2 per cent., sodium chloride 4·0 per cent., potassium dihydrogen phosphate 0·1 per cent. dipotassium hydrogen phosphate 0·2 per cent., and ferrous ammonium sulphate 0·1 per cent.) was inoculated with the culture with different salts of organic acids as sources of carbon. The results are shown below.

TABLE V

Source of carbon	Sodium formate	Sodium succinate	Sodium oxalate	Sodium lactate	Sodium acetate	Sodium citrate
Blackening in days	nil	nil	nil	3	nil	nil

Thus it was found that so far no other salt except sodium lactate was found to be utilised by the organism.

8. *Concentration of sulphates.*—A basal medium (composition: sodium chloride 6 per cent., dipotassium hydrogen phosphate 0·2 per cent., sodium lactate 0·2 per cent., ammonium chloride 0·2 per cent., ferric chloride 0·1 per cent., containing increasing concentrations of sodium sulphate was inoculated with the organisms, and inoculated as usual. The results are shown in Table VI.

TABLE VI

Concentration of sulphates	0·0	0·1	0·2	0·5	1·0	2·0	4·0	6·0	8·0
Blackening in days	nil	nil	2	2	3	3	4	6	nil

The concentrations of sulphate effective in blackening ranges between 0·2 and 2·0 per cent.

9. *Role of fixatives.*—It was found that sulphuretted hydrogen formed during the reaction, if allowed to accumulate, proved toxic to the micro-organism. It was observed that the culture maintained its activity over a longer period (upto two months) if adequate amounts of iron salts were incorporated in the medium.

Thus it is concluded that the organism has

TABLE III

Concentration of sodium chloride in the medium per cent.	0	0·5	1·0	2·0	3·0	4·0	5·0	6·0	7·0	8·0	9·0	13·0
Blackening in......days	7	6	5	4	4	4	3	2	4	5	6	6

TABLE IV

Form of Nitrogen	No nitrogen	$(NH_4)_2SO_4$	$NaNO_2$	$NaNO_3$	Urea	Casein hydrolysate	Peptone
Blackening......in days	No blackening	4	nil	nil	2	3	3

an optimum temperature of 30° C. and a thermal death-point at about 60° C. It requires a hydrogen-ion concentration of 7·2-7·4 and is a strict anaerobe. The optimum salinity at which the organism is most active is 6 per cent.; organic sources of nitrogen are preferred; of the sources of carbon studied, only sodium lactate was effective. The organism reduces sulphates in concentrations upto 6 per cent. The viability of the culture is enhanced by fixing the sulphuretted hydrogen released during the reaction with the aid of iron salts.

Our grateful thanks are due to the Madras Government for the generous support of a scheme of which these studies form a part. Thanks are also due to Sir J. C. Ghosh for his kind interest in the course of the work.

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September 1, 1945.

CHEMICAL EQUILIBRIUM IN STYRENE FORMATION FROM ETHYL-BENZENE AT LOW PRESSURES

THE chemical equilibrium in the dehydrogenation of ethyl-benzene to styrene has been successfully studied in a specially devised apparatus at the low pressures of 10 to 40 mm. of mercury and in the temperature range of 360-500° C. A catalyst, composed of the oxides of chromium and aluminium promoted by metallic copper, was used. This catalyst, prepared by a special method has been found to possess remarkable activity. Even at atmospheric pressure and upto the temperature limit of 580° C. it gave practically equilibrium yields of styrene from ethyl-benzene.

Using the equation $K_p = \frac{p\alpha^2}{1-\alpha^2}$ where α is the degree of dissociation of ethyl-benzene and p the total pressure in atmosphere, the equilibrium constant of the reaction has been calculated.

$$C_6H_5CH_2 \cdot CH_3\ (g) \rightleftarrows C_6H_5CH{=}CH_2\ (g) + H_2$$

From the value of K_p, the free energy of the reaction has been evaluated, using the relation:

$$\Delta F_T = -RT l_n K_p.$$

The following table gives the values of k_p and ΔE_T for five different temperatures:—

No.	Temp. °C.	Temp. °K.	K_p	ΔF_T (cals.)
1	360	633	0·00047	9636
2	395	668	0·00160	8545
3	430	703	0·00495	7414
4	460	733	0·01200	6442
5	495	768	0·03100	5299

Using graphical method, the mean value of the heat of reaction (temperature range 360-500° C.) has been found:

$$\Delta H_T = 29{,}840 \text{ cals.}$$

The free energy as a linear function of temperature is expressed by the equation:

$$\Delta F_T = 27{,}379 - 32 \cdot 65\ T.$$

Th temperature of neutral equilibrium is:

$$T_0 = 565\ ^\circ C.$$

Employing the specific heat equation,

$$\Delta c_p = 8 \cdot 52 - 0 \cdot 01405\ T + 0 \cdot 000{,}00566\ T^2$$

evaluated from the values of the specific heats for ethyl-benzene and styrene given by Daniel R. Stull,[1] the following standard free energy equation for the reaction has been obtained:

$$\Delta F_T = 27{,}097 - 8 \cdot 52\ T\, lnT + 0 \cdot 007025\ T^2 - 0 \cdot 000{,}00094\ T^3 + 23 \cdot 38T$$

The values of the heat of reaction, free energy and entropy change at standard state are:

$$\Delta H_{298} = 29{,}062 \text{ cals.};\ \Delta F_{298} = 20{,}229 \text{ cals.};\ \Delta S_{298} = 29 \cdot 64 \text{ E.U.}$$

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ROLE OF WATER-SOLUBLE PHOSPHORIC ACID AS AN ASPECT OF SEWAGE IRRIGATION

SEWAGE is a fairly rich source of phosphoric acid and nearly one-third of it is in water-soluble form. During sewage irrigation the crop gets readily available phosphoric acid throughout its growth period. This may play a significant role in crop-nutrition as was shown by the senior author[2] in the case of Ragi (*Eleusine coracana*). The phosphoric acid of sewage was shown to be as much responsible for the higher crop yields of Ragi as the nitrogen of sewage and it was also observed that the phosphorous content of Ragi definitely increased due to sewage irrigation. Similar experiments with wheat are now reported.

Using the local black cotton soil, pot experiments with wheat were laid out to study the effect of irrigating the crop with (1) water containing 2 p.p.m. of water-soluble P_2O_5 from superphosphate, (2) water containing 2·5 p.p.m. of soluble nitrogen as ammonium sulphate, and (3) water containing a combination of the above. The last is supposed to represent sewage irrigation. (4) A control of ordinary irrigation was also run. Each treatment was replicated four times. The amount of P_2O_5 and N corresponding to 250 lbs. and 300 lbs. respectively per acre were given in 30 irrigations of 4 gallons each per pot. The yields

of grain and straw along with their N and P_2O_5 contents are given below:—

Control		N. irrigation	P. irrigation	N. P. Irrigation	Standard error	Critical difference P = 0·01
Yield in gm. per pot						
Grain	11·2	19·5	17·7	19·7	1·81	2·75
Straw	8·5	15·7	14·0	19·2	2·72	5·08
N Per cent.						
Grain	2·24	3·27	2·95	3·36	0·18	0·27
Straw	0·33	1·17	0·63	1·36	0·21	0·31
P_2O_5 Per cent.						
Grain	0·76	0·71	1·10	1·12	0·11	0·17
Straw	0·07	0·07	0·33	0·61	0·11	0·17

There are significant increases in yields of grains as well as straw either with P- or with N-irrigation. This shows that the soil under experiment responds to application of both N and P. The response to P application may be due to the low available phosphate status of the soil which was found to be 20-25 p.p.m. as per Truog's method. As may be expected, due to N-irrigation, there is significant increase in the nitrogen contents of both grains and straw but not in their phosphorus contents. But due to P-irrigation the phosphorus as well as the nitrogen contents of grain and straw show a significant increase. This is contrary to the observation of the senior author[3] and also of Mukherji and Agarwal,[5] Joret and Malterre[4] and Anne.[1] They found that application of the phosphoric fertilisers in bulk at the beginning of cropping to a P-deficient soil, decreased the nitrogen content of both grain and straw. Thus the effect of application of water-soluble phosphoric acid in irrigation water is distinctly different from that of its application in bulk at the beginning of cropping. As a result of P-irrigation not only more phosphorus but also more nitrogen was made available which resulted in higher crop yields and higher nitrogen and phosphorus contents of both grain and straw. This aspect is being further studied.

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OCCURRENCE OF GOSSYPOL

Though gossypol was first discovered in the cotton seed, it was considered by Carruth[1] to be present in all parts of the cotton plant excepting the woody tissues. This conclusion was based only on the fact that the glands of all these parts gave with concentrated sulphuric acid a characteristic blood-red colour and with alkali a blue colour on exposure to air. But, these colour reactions obtained by Carruth with the several parts of the cotton plant appear to be due to the presence of small amounts of anthocyanins, since even acetic acid gives a permanent red colour. Carruth[1] also reported the extraction of a crude material containing gossypol from the ether extract of the stem-bark but it was not confirmed. Later, Harrison and Hahn[2] showed that the root-bark of the upland short cotton is a rich source of gossypol containing upto a maximum of 0·88 per cent. They also showed that stalk, bark-free root, leaves, squares, and immature bolls contained little or no gossypol. These facts are now confirmed by examining samples of a number of species of cotton plant available in South India.

The method of extracting gossypol employed here is that of Murty, Murty and Seshadri[3] which involves the cold percolation of the dry root-bark with chloroform and precipitating the compound in the form of its dianil with aniline. The recovery of gossypol from the dianil has been effected by means of acetic anhydride. This method of extraction gives the best yields in all the cases examined. The following table gives the data relating to the different sources.

Material	Method of extraction	% Yield of gossypol
1. Seed of *Gossypium hirsutum* (Cambodia)	Method of Murty, Murty and Seshadri	0·7
2. Root-bark of upland cotton according to Harrison and Hahn	Ether extraction	0·88
3. Root-bark of *G. arboreum*	Murty, Murty and Seshadri	1·29
4. Root-bark of *G. hirsutum*	,,	2·6
5. Root-bark of *G. indicum*	,,	3
6. Stem-bark of *G. hirsutum* and *G. indicum*	,,	Nil

As can be noticed the yields of gossypol from the root-bark are much higher than those reported by Harrison and Hahn. This may partly be due to the improved method of extraction adopted in the present examination. Besides being an excellent source it should be noted that the root-bark is free from oil unlike the seed and this makes the extraction very convenient and simple.

The sample of gossypol obtained from the root-bark has been carefully compared with

that obtained from the seeds by the preparation of derivatives and shown to be identical.

The stem-bark which has been carefully freed from any root-bark, on the other hand, yields no significant amount of gossypol. No crystalline matter could be obtained under the conditions employed for the preparation of anil.

Gossypol seems to be specially peculiar to the cotton plant (gossypium group) since the seeds and root-barks of other related plants resembling cotton do not contain gossypol.

Our thanks are due to Prof. T. R. Seshadri for his interest in this work.

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ON THE VIABILITY OF PADDY SEEDS *ORYZA SATIVA*

STUDIES on the longevity of seeds have engaged the attention of the various research workers. Takagi[7] in mulberry seeds, Kincaid[4] in tobacco seeds, Griffiths[3] in lettuce seeds, Akamine[1] in number of garden and crop plant seeds including rice stored for six years, Kondo[5] in hulled rice stored for four years and Christidis[2] in cotton seeds, have found that by reducing the moisture of the seeds and storing the same under air-tight conditions, viability of the materials is maintained for a longer period. Rodrigo[6] stored air-dried farm crop seeds including rice in air-tight containers. The study was extended for 95·8 months during which period seeds from all the paddy varieties that were stored lost their complete viability in 84·5 months.

Paddy seeds stored under ordinary conditions at Sabour were found to lose complete viability in about nine months. To ascertain the period for which paddy seeds could be made to remain viable, seeds from one pure strain, 36 B.K., were stored after one month from the date of harvest, in various kinds of containers mentioned below. After a lapse of 27 months from the date of storage, samples from the various containers were taken up to determine the viability of the seeds and the results obtained are given below.

The percentage of germination was nil when the method of storage was (1) air-tight tin containers, (2) earthen pots with mouth closed with mud, (3) earthen pots with mud plastered all round, (4) earthen pots with coal-tar plastered all round, (5) glass-stoppered bottles, (6) glass-stoppered bottles with tin-mercury amalgam, (7) desiccator without any desiccating agent (not vacuum), (8) desiccator without any desiccating agent (in vacuum); a hundred per cent. germination was, however, obtained when the method of storage was (9) desicator with calcium chloride, (10) desiccator with calcium chloride (in vccuum), and (11) desiccator with sulphuric acid.

Moisture percentage of the seeds from containers[9,10,11] was found to be 3.6 per cent. as against the 10-12 per cent. of moisture characterising the other seeds. The reduction in moisture content may be responsible for maintaining the full viability of the seeds.

Seed moisture from one pure strain, 36 B.K., of paddy was, therefore, reduced by drying them in the hot sun in the month of May to 4·5 per cent. and 3·6 per cent. and such dried samples were stored in sealed tin containers without any dehydrating agent in several sets. After the expiry of each year, of storage, samples from these containers were taken out to determine their germination percentage. After seven years of storage samples are still continue to show about 80 per cent. of germination. The maximum period, for which they maintain their viability, is still under observation.

A research worker who is testing a large number of varieties and strains under limited means, may thus store a part of his materials with complete safety for some years against loss of viability for examination later on. Moreover seeds of selected varieties and strains, which have been given out for propaganda and demonstration, may be preserved and the labour of maintaining them every year may thus be easily saved.

Grateful acknowledgment is due to late Mr. M. Alam, Rice Specialist, and to Dr. R. H. Richharia, Economic Botanist, Bihar, for giving facility for this work.

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SEED TRANSMISSION OF MELON MOSAIC VIRUS

IN connection with the analytical work on viruses nursery of cucurbitaceous plants, *e.g.*, cucumber (*Cucumis sativus* L.), 'tori' (*Luffa ægyptiaca* Mill.), red gourd (*Cucurbita maxima* Duschesne), bottle gourd (*Lagenaria vulgaris* Ser.), bitter gourd (*Momordica cha-*

rantia L.), melon (*Citrullus vulgaris* Schrod) and 'sarda' of Kabul (*Cucumis melo* L.) was raised in sterilized soil in the insect-proof glass house. In the first instance only twelve plants of each type were raised. All the plants thus raised appeared to be perfectly healthy excepting one plant of *Cucumis melo* which showed symptoms of virus infection. At the time the nursery was raised, there was no infected plant in the insect-proof cabin but as a precaution the plants were regularly sprayed with soap and nicotine sulphate twice a week. The occurrence of this case of infection was noteworthy as the disease was suspected to be transmitted through seed. The seeds of *Cucumis melo* were sown during January-February 1945. The germination was much delayed due to prevailing low temperature and the growth of the plants was slow. The first symptoms of infection were observed within a week after the appearance of the first true leaf. The infected leaf first became pale in colour and then gradually developed circular interveinal mottle accompanied by puckering of the leaf-surface. Within the next few days puckering developed to such an extent that the whole leaf appeared to be distorted and the leaf-apex was raised upwards. By this time the plant had put out two more leaves which also showed slight puckering and interveinal mottle (Fig. 1).

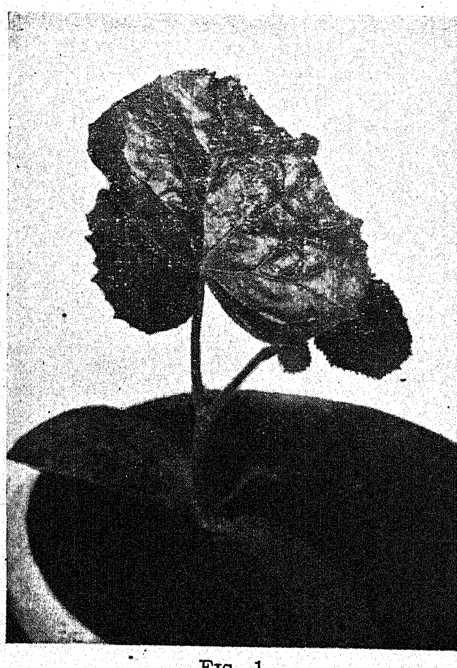

FIG. 1

Seed of *Cucumis melo* as well as that of other cucurbits except *Lagenaria vulgaris* Ser. had been purchased from the local market in one lot. The nursery of all the cucurbits was raised in several lots at different times but no case of seed transmission except in *Cucumis melo* was observed. Large number of plants of *Cucumis melo* were raised by planting fifty seeds at a time from the same lot but only 56 per cent. of the plants indicated seed transmission of the virus.

The disease was succesfully transmitted by mechanical means to some cucurbitaceous plants, *e.g.*, *Cucumis sativus*, *Momordica charantia* and to some solanaceous plants, *e.g.*, *Datura stramonium* L. and *Nicotiana tabacum* L. Var. *German samson*. The period required to bring about infection in different hosts varied from 4-7 days. The disease could also be transmitted to cowpea (*Vigna sinensis* Endl.).

The reactions on differential hosts indicate that the causal virus is a strain of *Cucumis Virus*[1] (Doolittle) and that the virus is seed transmitted. The results are similar to those of Kendrick (1934) who described a mosaic disease of musk melons (*Cucumis melo* L.) and proved the disease to be seed transmitted. McClintock (1916) indicated that cucumber mosaic virus might be seed-borne and Doolittle and Gilbert (1919) reported seed transmission of the cucumber mosaic virus by the wild cucumber. The symptoms of squash-mosaic-virus were described by Middleton (1944) who demonstrated the disease to be seed transmitted. Mahoney (1935) also observed seed transmission of a cucurbit virus and reported maximum seed transmission of 33·3 per cent.

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MUSTARD-APHID (*RHOPALOSIPHUM PSEUDOBRASSICAE* DAVIS)

Rhopalosiphum pseudobrassicœ Davis is one of the most serious pests of mustard. In the beginning of the attack the inflorescence of the mustard plant becomes thickly covered with the aphids, as a result of which most of the flowers are destroyed and those that are saved from the attack produce under-developed pods which in their turn become dried up and produce more or less nothing. Later on, the whole plant becomes covered with the

aphids of all stages, their moults, their excreta and the honey-dew: the whole plant is thus destroyed and the crop fails completely. Besides attacking mustard it also attacks many other cruciferous plants, *e.g.*, radish, cabbage, etc. It has also been recorded that the aphid transmits a number of virus diseases, *viz.*, *Brassica virus* 3—causing mosaic of Brassicæ, *Matthiola virus* 1—causing mosaic in stocks, *Phaseolus virus* 1—causing common mosaic in leaves, *Allium virus* 1—causing yellow dwarf in onions. The aphid appears to be of a very great economic importance.

In the beginning of December the *Sexuales*, *i.e.*, the winged males and females appear which copulate and the latter lay eggs on their host plant, *i.e.*, mustard or other cruciferous plants. This is the only time during their whole life-cycle when males appear and the females are oviparous. From the eggs emerge nymphs which are all females and no males at all. The females so produced are apterous, viviparous and parthenogenetic, and are known as *Fundatrices*. The apterous females are not so well developed as the winged females. The sense organs, antennæ and legs are much reduced, and this reduction of the parts is perhaps corelated with their increased reproductive capacity. The fundatrices in their turn lay nymphs which also develop only in apterous, parthenogenetic and viviparous females known as the *Fundatrigeniæ*, without producing any males as in the former case. There are generally three generations of fundatrigeniæ while the fourth generation develops into *Migrants* which are winged, viviparous and parthenogenetic females, and here again there is no reproduction of males. The migrants seldom lay nymphs on the same host, *i.e.*, the host of their mother, and even when the nymphs are laid on the same host, they seldom develop into adults. In fact the migrants always fly to some secondary host where they lay nymphs and perhaps remain there till the end of November, and thus the migrants are responsible for their propagation. The nymphs laid by the fundatrices moult four times before they become fundatrigeniæ whose nymphs also moult four times to become migrants. In the first fortnight of March these moults are completed in eight to ten days. The adults begin to reproduce, *i.e.*, begin to lay nymphs two to three days after the last moult. During the second fortnight of February and the first fortnight of March both the fundatrigeniæ and the migrants are found in the field. Sometimes the population of the migrants becomes so high that the whole vegetation and the sky round about the mustard fields become covered with them. The migrants which are lucky enough so as to reach their suitable host similarly reproduce on their own account. The observations show that the progeny of the migrants of whatever age it may be, is unable to feed itself on mustard even though they may be young and green, therefore it may be said that the migrant stage of the aphid is not a pest of mustard.

My grateful thanks are due to N. M. Deshmukh, Esq., Director of Agriculture, Gwalior Government, for helpful encouragement and to Mr. S. D. Hardikar, my colleague, for going through the manuscript.

A detailed study of the aphid is in progress and will be presented in due course.

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A STUDY ON THE LIFE CYCLE OF *BRUCHUS ANALIS* FEB., THE COMMON PULSE BEETLE

THE life-cycle was studied under laboratory conditions at a constant temperature of 92° F. The data given below have been recorded at this temperature.

Duration of the egg stage.—The average of twenty-five cases studied was 5½ days with 5 days as the minimum and 6 days as the maximum.

Duration of the larval stage.—It is an interesting fact that the duration of this stage was very much longer when it was fed exclusively on *Cicer arietinum* than when it was fed on various species of *Phaseolus*. The undermentioned observations were recorded.

TABLE I

Grain on which larva was fed	Average larval period in days	Number of cases studied
Phaseolus mungo ..	11½	15
Phaseolus radiatus ..	11½	14
Phaseolus acontifolius ..	11½	5
Cicer arietinum ..	17½	7

Duration of the pupal period.—The actual pupation took place about 24 hours after the formation of the lid-like exit for the adult. The following data were recorded.

TABLE II

Pupal period in days	Number of cases studied
7	3
8	11
9	7
10	1
	TOTAL 22

The average pupal period at 92° F. worked out to be $8^3/_{11}$ days.

The adult stage period was studied in a large number of cases. The average for the female was 9·5 days and for the male 9 days. The beetles were fed on powdered grain.

The oviposition started on the day following emergence. The male and the female that emerged on the same day were taken as a pair

TABLE III

The Rhythm and Duration in Days of Oviposition of B. analis *Fab.*

Sl. No.	Date of emergence of pair	Date of Ist egg laying	The rhythm of Egg laying on days											Total eggs laid	Last date of egg laying	Total egg laying period in day
			I	II	III	IV	V	VI	VII	VIII	IX	X	XI			
1	4·2·1944	5·2	5	8	8	9	11	11	8	6	3	—	—	69	13·2	9
2	4·2·1944	do	6	12	16	17	15	14	10	8	2	—	—	100	do	9
3	do	do	6	8	11	11	17	12	10	5	3	—	—	83	do	9
4	do	do	6	10	12	11	20	14	6	3	—	—	—	82	12·2	8
5	5·2·1944	6·2	27	16	13	15	15	10	6	2	—	—	—	104	13·2	8
6	do	do	15	15	10	10	11	8	5	3	—	—	—	77	dc	8
7	do	do	17	17	13	13	11	9	2	1	1	—	—	84	14·2	9
8	do	do	4	16	13	13	13	11	9	3	—	—	—	82	13·2	8
9	6·2·1944	8·2	—	8	8	15	10	10	10	7	—	9	2	79	16·2	9
10	do	7·2	8	9	9	17	10	13	9	6	—	—	—	81	14·2	8
												Average say 84		84·1		8·5 days

for further study. They all mated on the same day as they emerged. The pair continued to lay eggs for about 9 days. The average number of eggs laid by a pair was 84 with 69 as the minimum and 104 as the maximum. The maximum number of eggs laid by a pair on any one day was 27. The pairs continued to lay eggs for 8 to 9 days.

The rhythm of oviposition was observed in 10 pairs as detailed in Table III. Ten fresh grains of white gram were offered every day to each pair for noting the number of eggs laid on that day. The bruchid, as far as possible, made an even distribution of its quota on the grain. Mostly one, otherwise two eggs were laid on each grain.

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OSTEOMETRIC DETERMINATION OF SEX FROM THE HEAD AND THE LOWER END OF THE FEMUR

FIGURES for osteometric determination of sex from the head of the femur and its lower end are available for English bones.[1,2] As similar figures in Indians would provide interesting records for medico-legal workers, 186 fresh, adult bones (of both sexes) were examined. Maximum and minimum diametres of the head, and maximum width of the lower end (excluding epicondyles) were recorded in millimetres. The results are given in Tables I and II.

TABLE I

Sex of bone	Diameter of the head							
	Maximum				Minimum			
	Highest		Lowest		Highest		Lowest	
	mm.	%	mm.	%	mm.	%	mm.	%
Male	56	0·6	41	5·4	51	2·7	40	8·2
Female	43	12·8	35	2·5	43	5·1	34	2·5

TABLE II

Sex of bone	Maximum diameter of the lower end			
	Highest		Lowest	
	mm.	Percentage	mm.	Percentage
Male ..	83	0·9	67	1·8
Female ..	69	7·7	59	15·3

Evaluation of these results, after allowing for sources of error, makes it possible to draw the following conclusions:—

(1) A bone with a maximum or minimum diameters of the head above 44 mm., and width of the lower end above 70 mm. is most likely to be that of a male.

(2) A bone with similar diameters below 40 mm. and 70 mm. is just as likely to be that of a female.

(3) A bone with the above diameters of the head between 40 mm. and 44 mm., and of the lower end between 66 and 70 mm., may belong to either sex. Osteometry is of no use in such cases.

As the bones for investigation, under report, were from the British Indians (Punjabis) the results would be applicable primarily to the residents of the Punjab.

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ON A NEW COCCIDIUM *WENYONELLA GALLINAE* N.SP., FROM THE GUT OF THE DOMESTIC FOWL, *GALLUS GALLUS DOMESTICUS* LINN.

In September 1944, a natural outbreak of coccidiosis occurred amongst four to six-week old chickens at Mukteswar. Four birds in one cage were attacked, of which three died. Another chick of about the same age died of the infection in October. The affected chickens passed blackish-green semi-solid excreta which contained numerous unsporulated oöcysts. On post-mortem examination, one of the birds showed pin-point hæmorrhages in the mucosa of the terminal part of the intestine, the wall of which was thick and congested. The gut contained a greenish fluid which abounded in oöcysts. In 2·5 per cent. solution of potassium bichromate, oöcysts took four to six days to complete their sporulation at 28° C. The tetrazoic tetrasporocystid nature of the oöcyst at once relegated this organism to the genus *Wenyonella* Hoare (1933).

Only five species of *Wenyonella* have been reported to date, *viz.*, (1) *W. africana* Hoare (*loc. cit.*) from an African snake, *Bœdon lineatus,* (2) *W. hoarei* Ray and Das Gupta (1935, 1937) from an Indian squirrel, *Sciurus* sp., (3) *W. uelensis* van den Berghe and (4) *W. parva* van den Berghe (1938) from Congolese rodents, *Funisciurus anerythrus* and *Tamiscus emini* respectively, and (5) *W. bahli* Misra (1944) from the common grey quail, *Coturnix communis.* A comparison of these species in respect of the shape and dimensions of oöcysts and sporocysts and their contents with this coccidium has convinced the author that it belongs to a new species. It has, therefore, been designated as *Wenyonella gallinæ* n. sp., the specific name being given after the generic title of the host.

Three young birds were fed with sporulated oöcysts of *W. gallinæ.* Concurrent with the passing of blackish-green semi-solid excreta, one showed unsegmented oöcysts in its fæces on the seventh day and two others on the eighth day. Thereafter, oöcyst elimination continued for three consecutive days, when the colour and consistency of the fæces returned to normal.

The life-cycle of this organism and its pathogenicity to young and old birds is being studied in detail. Since this is the first record of *Wenyonella* from chickens the author has described the oöcyst only with a view to help investigators on poultry diseases to distinguish it from members of the genus *Eimeria.*

Description of the oocyst—Oöcysts are oval or egg-shaped. The ectocyst is 1·34 to 1·5μ thick. Its surface presents a punctate appearance and in optical section, appears rugged (Figs. 1 & 2). The endocyst is thin and is interrupted at the narrow micropylar end. Size of the oöcyst varies from 29·48 μ to 33·50 μ in length and

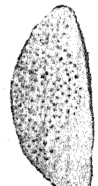
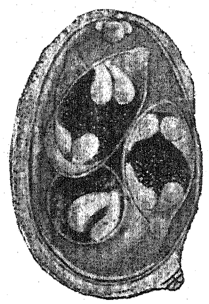


FIG. 1

FIG. 2



Wenyouella gallinae n. sp. × 1100

FIG. 1. Surface view of a portion of eclocyst.

FIG. 2. A mature oöcyst.

19·84 μ to 22·78 μ in breadth. Sporocysts appear as short-necked round-bottomed vials. The four sporocysts occupy almost the whole space within the oöcyst. There is a hyaline plug-like structure at the neck-end of each sporocyst. Each sporocyst, measuring 18·76 μ in length and 8·04 μ in breadth, contains four club-shaped sporozoites and a granular residue. Sporulation time varies from four to six days at 28° C.

Systematic position—*Wenyonella gallinæ* n.sp. (Eimeriidea, Coccidiida).

Host—The domestic fowl, *Gallus gallus domesticus* Linn.

Habitat—Epithelium of the terminal part of the intestine.

Locality—Mukteswar, Kumaun, U.P., India.

I am indebted to Mr. J. R. Haddow of this Institute for handing me the material for study.

Imperial Veterinary Res. Institute,
Mukteswar, Kumaun, U.P., H. N. Ray.
September 12, 1945.

1. Van den Berghe, L., *Parasitology*, 1938, **30**, 275. 2. Hoare, C. A., *Ibid.*, 1933, **25**, 359. 3. Misra, P. L., *Proc. Nat. Inst. Sci., India*, 1944, **10**, f203. 4. Ray, H. N., *Science and Cultuae*, 1935, **1**, 112. 5. Ray, H. N., and Das Gupta, *Parasitology*, 1937, **29**, 117.

REVIEWS

Advances in Nuclear Chemistry and Theoretical Organic Chemistry. Edited by R. E. Burk and Oliver Grummitt. (Interscience Publishers, Inc., New York, U.S.A.), 1945. $ 3.50.

The volume under review, the third of a series, presents the substance of a course of lectures by men of distinction in their field designed "as a mechanism for presenting to graduate students the flow of chemical research and for keeping industrial chemists abreast of their science". The forward movement of science is taking such rapid strides that keeping abreast is no easy task, especially when frontier subjects are concerned and the gap between undergraduate courses and research is one that requires to be closed by methods similar to those adopted by the Western Reserve University in the present series. One is tempted to add that the position is worse in the case of courses in some of the older Universities in this country and the task of bridging the gulf more formidable.

The volume presents five different branches and by no means can be considered to cover the full ground that may be expected by the title but within the compass of the small monograph, the ground covered has been well presented. Dr. Keston has outlined the use of isotopic tracers in the study of biochemical problems. The introductory section is followed by one on stable isotopes which gives a brief account of methods of concentration of isotopes besides a note on the Bleakney-Rittenberg mass spectrometer, a description of which is absent even from recent text-books. The last section gives a good picture of the use of both stable and radioactive isotopes in the study of animal metabolism.

Professor Taylor has given a lucid review of the use of isotopic tracers in elucidating the mechanism of heterogeneous reactions. The short contribution gives a critical account of exchange reactions involving deuterium as well as the various reduction processes. The importance of this tool in investigating technically important reactions is brought to notice in the study of, the exchange reactions of nitrogen isotopes.

Dr. Crane has given the basic principles underlying the different methods adopted in nuclear physics for the production of high energy projectiles. The last section of this short contribution deals with the 'practical applications of nuclear physics' which, however, does not include the destructive use of this power that was to come!

The considerable attention that has been given to the refinement of classical structural theory of organic chemistry during the last fifteen years, naturally, leads one to expect a section on Resonance in a book of this type and the contradiction by Dr. Brooker on the subject covers the greater part of the volume. A brief survey of the application of this concept in the interpretation of molecular structures is followed by an account of the applications to a few problems in organic chemistry. As the author himself remarks, the selection of topics is somewhat arbitrary and one would certainly like a fuller treatment of even some of the topics dealt with. The longest single section is devoted to the problem of colour and constitution which has been Dr. Brooker's special field of study and the account gives a fairly good picture of the correlation between absorption and dye structure leading to a classification of dyes of the linear resonator group according to the degree of degeneracy of the extreme structures.

The last contribution is on the Hydrogen-bond by Prof. Rodebush who introduced the term about twenty years ago. All the essential points pertaining to the hydrogen-bond have been well brought out and there is besides a very useful section dealing with natural products and the synthetic substitutes in which this bond plays a large role.

The get-up and printing of the volume are attractive and considering the material presented, the price is not excessive. The book deserves a place in any good library.

S. V. ANANTAKRISHNAN.

A Class-Book of Botany (for Intermediate and Medical Students). By A. C. Dutta. Sixth Edition (revised and enlarged). (Published by Oxford University Press, Indian Branch), 1945. Pp. 464. Rs. 7-8.

Prof. Dutta's Class-Book on Intermediate Botany has been in existence since 1929 and, therefore, needs no special introduction to students and teachers. It appears from the number of editions it has passed through during the period of war as compared to pre-1939 period, that its demand for the class-room is on the increase. One of the indications is that the student prefers to have text-books with Indian examples of flora rather than those with foreign flora dealt as types. The present edition is considerably expanded, particularly regarding the illustrations in almost all the chapters. The arrangement of subject-matter under the different chapter heads remains the same as in any standard text-book of Botany, *viz.*, Morphology, Histology, Physiology, Ecology, Systematic Botany, Cryptogams, Gymnosperms, Evolution and Genetics. In any system of teaching biological sciences, the *liaison* between teacher and taught is a well and accurately illustrated text-book which takes the student into the subject gradually in simple language. This aspect has been given considerable emphasis in the edition under review.

Taking individual chapters, the one on Histology is very well written followed by the one on Physiology as the second best;

considerable expansion having been made over the former editions under the latter. The chapter of Systematic Botany is based on Bentham and Hooker's system, which is still very widely followed in every institution in this country, although the author has made attempts to briefly explain the Linnaen system and Engler's system of classification. Under the dicotyledons, the sub-classes included are Polypetalæ, Gamopetalæ and Incompletæ whereas, under the Monocolyledons, the sub-classes are Uitaloideæ, Spadicifloræ and Glumifloræ. Special emphasis on the economic side of Systematic Botany would have, perhaps, enhanced the value of this chapter.

The chapter on Cryptogams might have been expanded further, particularly, under Algæ and Fungi, although the author has furnished adequate information, for in any case the discerning student always attempts to get additional knowledge from text-books usually prescribed for higher degree course. The final chapter on Evolution and Genetics may have to be considerably expanded since what the author has presented is too brief and not in keeping with the rapid advances made in this branch of botany. Indeed, this ultimate chapter terminates the book so suddenly that the undergraduate in the subject, for whom it is written, may not get any comprehensive birds's-eye-view of the significance of the part played by evolution in plant life. The book terminates with an appendix (standard questions in the different chapters) and a fairly exhaustive index. A note of appreciation of the author's difficulty in giving Bengali and Hindustani equivalents for the latinised names of plants may not be out of place. Considering the great number of languages in the country, standardization of the type attempted by the author should remain a dilemma for some time to come.

The text-book is well worth purchasing both by Intermediate students as well as the Medical students. T. S. SADASIVAN.

Food Famine and Nutritional Diseases in Travancore (1943-1944). Surveys by K. G. Sivaswamy, K. K. Chandy and ten Doctors. (Servindia Kerala Relief Centre, R. S. Puram Post, Coimbatore, S. India), July 1945. Pp. 265, with 33 illustrations. Rs. 5.

At about the same time as the famine was raging in Bengal, there was serious food shortage in certain parts of the west-coast of India, particularly Travancore, which received much less publicity. The Servindia Kerala Relief Centre has brought out a well documented account of the famine conditions that prevailed in Travancore during 1943-44 and grateful thanks are due to the efforts if its enthusiastic Secretary and to the noble band of doctors who helped him in his survey of the situation and its tragic repercussions. Evidence has been brought forward to show that the excess of deaths over the normal was directly attributable to famine and to diseases that followed in its wake. The book is replete with data to prove that a large percentage of deaths was due to diarrhœa, dysentery, œdema and other nutritional diseases. Chronic digestive troubles, due to excessive consumption of tapioca, a predominantly starchy food with a little protein, claimed a heavy toll. A study of the reports by the doctors shows that the number of fatal cases of diarrhœa and œdema was greater in the latter half of 1943 and in the beginning of 1944. These cases decreased slightly in the latter part of 1944, presumably due to an increased purchasing power of the people and the introduction of State-wide rationing. But, there was an increase in the incidence of anæmia, scabies and peripheral neuritis during this period. The illustrations are profuse and reveal at a glance the state of health of the poor during the critical period. The book is not a mere chronicle of famine and the conditions that led to it. Constructive suggestions are offered which are both practical and timely. The last two chapters discuss the food policy of the State and its relation to vital statistics.

The book contains some pathetic revelations: "A member of the family had to wait till the other person returned who had the one piece of untorn clothing they all had between them!" (p. 8); "Only 3 per cent. of the ration cards issued were found to be fully used" (p. 9); "Poor families surviving on 930 calories per adult a day" (p. 42); "Double ration for Government servants" (p. 141), etc., etc. The authors are very critical, and justifiably too, of some of the policies persued by the Government which accentuated the famine.

One wishes that such statements as the following had been avoided: "Another chief trouble that is found in this locality (Shertellay) is the frequent colds and coughs. Some cases of night-blindness (Nyctalopia) too are found here. These people improve well on a diet rich in vitamin D." One also wishes that the "Errata" were either omitted or made to include all the numerous printing and other errors.

On the back cover of the book occurs the following statement: "The west-coast man has belied the findings of nutritional experts by surviving on an extremely ill-sufficient and ill-balanced diet though with less energy, less vitality, and deterioration in health." No nutrition expert ever said that persons will not "survive" on diets furnishing less than the optimum and, therefore, their findings cannot be belied by the west-coast man. Only the second half of the sentence belies the first half. Servindia can better serve India not by driving meek consolation from mere "survival" on miserable diets but by insisting upon good food and health as the fundamental and inalienable right of every man and woman.

The book with its poor quality of paper and printing is priced unconscionably high.

S. RANGANATHAN.

SCIENCE NOTES AND NEWS

In the current issue of *Mycologia* (Vol. 37, No 4, pp. 499-526, 1945), Raper and Alexander have described the lyophil process of preserving moulds. Cultures are first grown on a suitable medium in a petri-dish for about ten days at which time the conidial production is at its optimum. The spores that are formed are collected and added to approximately 0·25 c.c. of sterile beef serum until the resulting suspension is comparatively dense. About 0·05 c.c. of the suspension are then placed in a sterile lyophil tube made of 4-inch lengths of 6 mm. pyrex glass tubing, sealed at one end and fire-polished at the other. The tube is then plugged with cotton, excess cotton being burnt off; the remaining portion of the plug is pushed into the tube to a depth of one-half inch to prevent the cotton from being drawn up into the apparatus during evacuation.

The lyophil tubes are now attached to a manifold and are lowered into a bath of dry ice and cellosolve at -40 to $-50°$ C., so that the ends of the tubes containing the spore suspension are submerged into it. The material gets frozen in a few seconds when the evacuation by means of a vacuum pump is begun. The tubes are gradually raised to a position where the temperature at the level of the frozen suspension is about $-10°$ C. The frozen suspension which at first was glassy, becomes chalky as drying proceeds and forms into a tiny pellet. The tube is then sealed off with a Hoke gas-oxygen torch, the whole process requiring about two hours.

Tests have shown that in the desiccated form, the spores remain viable for three and a half years or more. Only moulds have been so far tested for their longevity in this form. Cultures grown from such lyophil preparations have appeared entirely typical of the strains under observation in both colony characteristics and in structural details and variation caused by long cultivation on rich nutritive media has been kept at the absolute minimum. The high penicillin yielding strains of *Penicillium notatum* or *P. chrysogenum* retained their capacity to produce at original levels. Storage of lyophil preparations is comparatively easy, quadruplicate preparations of 300 separate cultures could be placed in a tray, $14·5 \times 12·5 \times 12·5$ at 3 to 5° C., and the tubes can be sent by air mail without much cost. M.

The Twenty-first Annual General Meeting of the Geological, Mining and Metallurgical Society of India was held in Calcutta on 24th September 1945. Sir Cyril Fox, the retiring President, was in the Chair and Mr. B. M. Birla was the Chief Guest.

Sir Cyril Fox's Presidential Address had as its theme the Economic Minerals Bureau which was the most important item that received the attention of the Society during the year. He described the proposed activities of the Bureau under five heads:

(1) An office to supply accurate mineral and metal facts relating to Indian industries.
(2) A bureau for the collection of information and data relating to geological discoveries and the mining and metallurgical industries throughout the world.
(3) An agency for registering and recommending geologists, mining engineers and metallurgists to firms and Indian States.
(4) A laboratory for making chemical analyses and assays, and conducting physical tests on mineral and metallic substances.
(5) A Council or Board to control efficiently the above branches of work.

Sir Cyril stated that though there was naturally certain differences as to details, there was remarkable agreement regarding the need for an Economic Minerals Bureau, and he was of the opinion that the Bureau should be established immediately with items (3) and (4) as the chief activities. He further made the valuable suggestion that in view of the paucity of experienced workers, the Bureau should provide for training geologists, mining engineers and geo-chemists. It is hoped that this proposal will be given effect to, for at present, there is no dearth of young men with Honours or Post-Graduate degrees who will do very well if only they are given training in geological and mine surveying, prospecting, and in mining, milling, and metallurgical operations.

To carry out the programme, funds are necessary and Sir Cyril estimated that Rs. 2,00,000 would be required at an early stage for capital expenses and about Rs. 50,000 per per for running expenses. He felt convinced that with the co-operation and help of Indian industrialists it should be possible for the Society to initiate the Economic Minerals Bureau, which would be a paying concern if it was organised on proper lines. He was of opinion that it should not be a State-aided institution but that it should co-operate with any geological, mining, or scientific institution and with Government.

Mr. B. M. Birla then addressed the gathering with India's industrialisation as his main theme. Sir Cyril had during the course of his Presidential Address, stated that it was an enormous belief that India was well-endowed with minerals, with which view he did not at all agree. He said that only about 500,000 square miles of India had been geologically surveyed, and that too only superficially, and even such a survey had shown great potentialities. He diagnosed the trouble with unerring precision when he said that what is required is greater investigation to ascertain the nature and quantity of our mineral resources—an investigation which can only be undertaken by qualified geologists. He was of the opinion that unless we had an adequate increase in the number of competent geologists, a quicker

survey could not be made of our resources, and he hoped that the Society would seriously endeavour to bring about an increase in the number not only of geologists, but of mining engineers and metallurgists, for unless we have a large number of such technically qualified scientists and engineers, the industrialisation of India and the raising of the standard of living of the country cannot be achieved.

Mr. Birla uttered a note of warning against the illusion that once we have political freedom, we shall have every other kind of freedom including freedom from want. Economic progress, he said, can only result if we work hard for it taking the fullest advantage of modern methods and discarding our fatalistic outlook that everything is pre-ordained and that we ourselves can do practically nothing to alter the course of events.

Mr. Birla welcomed the proposal for the establishment of an Economic Minerals Bureau and said that such an institution can justify its existence if it is well staffed and equipped and if it functions with the highest possible efficiency. He suggested that the Bureau's activities should also include the laying down of standards, mainly metallurgical, for performance under Indian conditions. Sir Cyril had said that it should not be a State-aided institution, but Mr. Birla was of opinion that as long as the Bureau was perfectly autonomous, he saw no reason why it should not accept financial assistance from the State in view of its usefulness to the country. He concluded his address with the hope that the Geological, Mining and Metallurgical Society would play an increasingly important part in the industrialisation of India.

The Geological, Mining and Metallurgical Society of India Council for 1945-46

President: Dewan Bahadur D. D. Thacker, Managing Director, Pure Jharia Coal Co., Ltd., and Hon. Magistrate, Jharia. *Vice-Presidents*: Mr. Sushil Chandra Ghosh, Colliery Proprietor, Universal Trading Co., 33, Canning Street, Calcutta; Prof. S. K. Roy, Professor of Geology, Indian School of Mines, Dhanbad. *Joint-Secretaries*: Mr. N. N. Chatterjee, Lecturer in Geology, Calcutta University, Calcutta; Mr. S. K. Bose, Prof. of Mining and Surveying, Indian School of Mines, Dhanbad. *Treasurer*: Mr. B. N. Maitra, Lecturer in Geology, Presidency College, Calcutta. *Librarian*: Mr. S. Ray, Lecturer in Geology, Presidency College, Calcutta. *Other Members of the Council (Elected)*: Mr. G. C. Chaterji, Geologist, Geological Survey of India, 27, Chowringhee, Calcutta; Dr. A. K. Dey, Geologist, Geological Survey of India, 27, Chowringhee, Calcutta; Mr. Chand Mall, Chief Mining Engineer, The India Mica Supply Co., Ltd., Giridih; Mr. T. N. Muthuswamy, Professor of Geology, Presidency College, Madras; Dr. K. P. Rode, Chief Geologist, Rohtas Industries, Dalmianagar, Bihar; Mr. P. H. Pandya, Agent, Messrs. Kalyanji Mavji & Co.'s Group of Collieries, Industry Colliery, Jharia; Mr. M. L. Shome, Assistant Superintendent of Collieries, B.B.C.I. Ry.'s Kurasia Colliery, P.O. Chirimiri, Korea State, E.S.A.; Prof. Daya Swarup, Principal, College of Mining and Metallurgy, Benares Hindu University, Benares.

The Royal Institute of Science, Bombay, will be celebrating its Silver Jubilee in the third week of November this year. The celebrations are expected to be inaugurated by His Excellency the Governor of Bombay, on the 15th November 1945, and will continue up to the 22nd November 1945. Other activities in this connection will be publication of a Commemoration Volume, a Science Exhibition which will be open to the public for four days, and a series of popular lectures by eminent Indian scientists.

Prof. J. N. Mukherjee, D.Sc., F.N.I., C.B.E., Ghose Professor of Chemistry, University College of Science, Calcutta, has been appointed Director of the Imperial Agricultural Research Institute, New Delhi. It is understood that he will join the new post sometime in the middle of October 1945.

Dr. T. S. Wheeler has been appointed Professor of Chemistry, University College, Dublin (National University of Ireland).

Dr. K. R. Krishnaswami, D.Sc., F.R.I.C., H.E.H the Nizam of Hyderabad Assistant Professor of Mineral Chemistry, Indian Institute of Science, Bangalore, has been appointed Industrial Chemist to the Government of Bihar.

Dr. Frank Adcock, D.Sc. (Lond.), Dr. R. G. Harris, M.A., D.Sc. (Edin.), F.R.S.E., and Major B. C. Carter, M.I.Mech.E., have been appointed Professors of Metallurgy, Aeronautical Engineering and Internal Combustion Engineering respectively, at the Indian Institute of Science, Bangalore. These are senior scientific officers, and have been lent by His Majesty's Government for a period of three years.

The Government of Madras has deputed Mr. K. V. Sundaram Ayyar, Additional Government Analyst, King Institute, Guindy, to visit the laboratories in England and America for making a special study of Food Chemistry in those countries. He will be spending six months on a tour of those countries. The Government, it is understood, contemplate the formulation of a scheme for the development of Food Chemistry and the opening of research laboratories as a part of their post-war reconstruction programme.

We asknowledge with thanks the receipt of the following:—

BOOKS

X-Ray Metallography. By A. Taylor. (Chapman & Hall, London), 1945. Pp. 400. Price 36/-.

Industrial Oil and Fat Products. By Alton E. Bailey. (Interscience Publishers, New York, N.Y.), 1945. Pp. x + 735. Price 10 dollars.

A Text-Book of Heat. By G. R. Noakes. (Macmillan & Co., Ltd., London), 1945. Pp. 469. Price 10/6.

The Physical Structure of Alloys. By C. E. Beynon. (Edward Arnold & Co., Ltd., London), 1945. Pp. 126. Price 6/6.

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CURRENT SCIENCE

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CENTENARY OF THE FARADAY EFFECT

EXACTLY a century ago, in November 1845, Faraday announced to the Royal Society the discovery of the phenomenon now known as the Faraday effect in his honour. The discovery was not made by accident but was the result of systematic experiments undertaken by Faraday in the hope of establishing a connexion between the phenomena of light and those of electromagnetism. His first attempts were to find whether an electrostatic field influenced the propagation of light through a material medium. As these experiments failed to yield an observable result, he was led to try the effect of a magnetic field. It was known at the time that a plate of glass under mechanical strain placed between crossed nicols gives a visible restoration of light. Hence, probably, Faraday was led to try a somewhat similar experimental arrangement in which an unstrained block of glass was placed between the poles of the electromagnet. A beam of light polarised by a nicol traverses the glass along the lines of magnetic force and then enters a second nicol which is set in the crossed position with respect to the first. In the absence of a magnetic field, the light transmitted in succession by the first nicol and by the block of glass is blocked by the second nicol. Faraday observed that when the electromagnet was excited, there was a visible restoration of light. That this was due to a rotation of the plane of polarisation of the light was shown by the fact that the light could again be quenched by a suitable rotation of the second nicol, the rotation necessary for this purpose increasing with the strength of the field and changing sign when the direction of the magnetic field was reversed. The magnitude of the effect depends greatly on the substance placed in the field. That Faraday succeeded in observing the phenomenon with the electromagnet of modest dimensions available to him was due to the fortunate circumstance that he used a block of special glass of high refractive index which he had himself manufactured in some earlier researches.

Faraday's discovery must have seemed strange and almost incomprehensible at the time to his contemporaries. In the fullness of time, however, it exercised a profound influence on the progress of physics. The phenomenon showed clearly enough that Faraday was right in thinking of electrical and magnetic actions as field phenomena and not as actions at a distance, as was then generally believed. Faraday's ideas, as is well-known, inspired Maxwell to develop his well-known theory of the electromagnetic field which indicated that light itself is an electro-magnetic wave-motion in space. Hertz's successful experiments of 1888 on the artificial production of electromagnetic waves were inspired in their turn by Maxwell's theory of which they were a confirmation. The identity of all forms of radiation in respect of their nature is now a commonplace of physics, but its recognition is nevertheless one of the greatest achievements of modern science, and it is well to emphasise that Faraday's discovery of his magneto-optic effect pointed the way to its establishment. Incidentally, it may be remarked that the Faraday effect has itself since been observed with electromagnetic radiations over a wide range of frequency. The rotation of the plane of polarisation of radio-waves in the upper layers of the earth's atmosphere by the action of the earth's magnetic field is now a well-established result. A similar phenomenon has also been demonstrated in the laboratory with short electric waves and a strong magnetic field, the necessary density of free electrons in the path of the waves being obtained by sending an electric discharge through a gas such as neon, argon or nitrogen at low pressure. The Faraday effect in the region of infra-red frequencies was observed very early in the history

of the subject. Curiously enough, its observation with ultra-violet radiation had to wait nearly half a century. More recently also, reports have appeared which indicate that the plane of polarisation of Rontgen rays is rotated in their passage through a thin sheet of iron placed in a magnetic field.

It is obvious that the presence of a magnetic field would have no effect on the passage of light through a transparent substance, unless the latter is itself capable of being magnetised by the field. This train of thought naturally induced Faraday to examine the question whether the block of glass used in his magneto-optic experiment was capable of magnetisation. Accordingly, he suspended the rod freely by means of a thread between the poles of the electromagnet and found to his astonishment that it set itself at right angles to the lines of magnetic force and not parallel to them as in the familiar case of an iron rod. This discovery naturally interested Faraday immensely, and he was so fully engaged in following it up that, as the story goes, he could not attend the meeting of the Royal Society at which his paper on the discovery of the magneto-optic effect was taken up for reading.

Most ordinary substances, both solid and liquid, which transmit light are diamagnetic like Faraday's block of glass. It is not surprising, therefore, that in practically all cases, the sense of the rotation of the plane of polarisation is the same, though the magnitude may be different in different substances. Even the so-called paramagnetic substances, which are attracted and not repelled by a magnetic field, show in most cases, rotation in the same sense as diamagnetic bodies. This is not surprising when we recall that diamagnetism is a universal property which must be assumed to exist, though in a suppressed form, even in paramagnetic substances. That the Faraday effect arises from the magnetisation of the medium is strikingly shown by the phenomenon (discovered by Kundt in 1884) of the rotation of the plane of polarisation of light in its passage through thin films of iron when placed in a magnetic field. The rotation in this case depends directly on the magnetisation of the film, reaching a saturation value at high field strengths, and altering with temperature in the same way as the magnetisation itself.

The observation of a special form of the Faraday effect characteristic of paramagnetic bodies was first made by J. Becquerel in 1906 and has recently received a great deal of attention. The distinction between the diamagnetic and the paramagnetic rotations arises in respect of the dependence of their magnitude on the temperature of the substance, the strength of the magnetic field and also its variation with the wavelength of the light. The most obvious difference between the two types of rotation is that the dispersion curve of the rotation is symmetric about a characteristic absorption frequency in the diamagnetic case and unsymmetric in the paramagnetic one.

The further question arises why, even granting the magnetisability of the medium, the propagation of light through it should be influenced by such magnetisation. It is clear enough that the answer to this question must be in the identity of the structures in the medium which are responsible alike for its magnetisability and for its influence on the propagation of light. Further, since the refractivity of a substance is connected with the possession by the substance of characteristic absorption and emission frequencies, it follows that the same structures must also be responsible for these latter properties. Thus, the successful observation of the Faraday effect involves as a necessary consequence that the characteristic emissions and absorptions of light by a substance would be influenced when the latter is placed in a magnetic field. It is on record that Faraday looked for such an effect but failed to find it. We may take it that the discovery of this phenomenon made by Zeeman in 1896 was prompted by the same train of ideas as that indicated above. Indeed, the magnetic behaviour of substances, the Faraday effect and the Zeeman effect are all intimately related to each other.

H. Becquerel in 1897 derived, from very simple considerations, a formula connecting the magnitude of the Faraday rotation with the field strength and the refractive dispersion of the medium for light of the particular frequency under consideration. Even according to the most recent theories, the diamagnetic part of the Faraday rotation in a medium composed of atoms is given exactly by Becquerel's formula. This is understood easily enough if we recall that a rotation of the plane of polarisation may be regarded as the result of a difference in the refractive index for left- and right-handed circularly polarised beams of light. In the absence of a magnetic field, the two indices would be identical. In the presence of the field, they would be different and the difference would be the same as that produced by a change of frequency of the light equal to twice the precession frequency of the electrons in the magnetic field given by the famous theorem of Larmor.

It is an interesting fact that the magnitude of the Faraday rotation in many ordinary substances (gas, liquid or solid) is given fairly accurately over the whole range of frequency of the visible spectrum and of the ultra-violet by the Becquerel formula. The observed rotation is, however, smaller than the calculated one by a constant numerical factor (less than unity) which may be called the magneto-optic anomaly of the substance. When we consider the complexity of the molecular structure of most ordinary substances, as also the complexity of their state of molecular aggregation, the appearance of such a simple numerical connection between the refractive dispersion and the Faraday rotation over a wide range of the spectrum must be considered very remarkable. Darwin and Watson, who in 1927 drew attention to the general validity of the Becquerel formula subject to this correction, remarked that while no anomaly greater than unity has been found and that while it is usually between 40 and 60 per cent., there did not appear to be any general principle governing the magnitude of the anomaly.

It is obvious that for real progress in the study of the Faraday effect, a satisfactory explanation of the magneto-optic anomaly referred to above is essential. We may regard the anomaly as a characteristic constant for the molecule, analogous to its optical anisotropy determined from studies on light scattering. A careful study of the figures given by Darwin and Watson shows that there is no direct or simple relationship between the magneto-optic anomaly and the optical anisotropy of a molecule. It is true that there are indications of such a connection, as for instance, in the fact that the constant is somewhat smaller for aromatic compounds than for aliphatic ones and is particularly small for substances such as carbon disulphide, nitrous oxide and nitrobenzene which show large depolarisations in light scattering. On the other hand, we have to consider the fact that the factor for carbon tetrachloride which is optically isotropic is 0·51, whereas for benzene which is highly anisotropic, it is 0·56. While, therefore, there is obviously no direct connection between the optical anisotropy and the magneto-optic anomaly of molelcules, the facts do not rule out a deeper connection in which the specific properties of the individual chemical bonds are involved. Long ago, in a remarkable series of investigations, W. H. Perkin showed that the magnetic rotatory power of organic compounds can be used as a powerful instrument for the study of their constitution. On the other hand, we also know that the optical anisotropy of a molecule is related both to its chemical constitution, and to its geometric configuration. The fuller elucidation of the relationship between these properties would obviously be a matter of great interest.

It is also now fairly certain that the Faraday effect can also be used with great success in the elucidation of the states of molecular aggregation. Here again, the problem centres round the explanation of the magneto-optic anomaly. Some progress has been made towards the solution of this problem in investigations undertaken recently at Bangalore. A fuller report of these investigations will appear in due course.

C. V. Raman.

SCIENTISTS' STUDY OF LAST SOLAR ECLIPSE

"Mass Attack" on Secrets of Radio-Wave Propagation

According to a plan made by the Committee under Sir Edward Appleton, the British physicists and radio engineers co-operated in a series of observations lasting for seven days and centred on the day of the eclipse to obtain the effects of the last solar eclipse upon the upper and lower ionospheres. This particular eclipse afforded an unique opportunity for examination of the solar effects upon the ionosphere, because it occurred near about noon in summer when the lower ionospheric layers were highly ionised and the upper ones were clearly defined and separated one from the other.

It is well known that the formation of the ionized layers, upon which all long distance radio transmission depends has to do with the energy radiated from the sun. It is however, not yet fully known whether the ultra-violet sunlight is solely responsible for this ionisation. It may be that swiftly moving particles of matter from the sun towards the earth also contribute to the effect in some degree. If the latter phenomenon also contributes to the ionisation, the effect of the particles being cut-off by the moon in their path should be observed at a different time from the eclipse itself. The effects of the "corpuscular eclipse" and "optical eclipse" were, therefore, observed.

The normal equipment for measurement of signal intensity, equivalent height of the ionised layer, critical frequency, and maximum equivalent ionic density was arranged to be operated as far north as possible so as to be near the track of totality. In ultra short-wave case, the "Radar" equipment of war-time was employed in the detection of the ionisation responsible for the "bursts" as well as other abnormal patches in the lower ionosphere.

Observations on American radio stations operating on very long wave-lengths were carried out by several organisations so that variation in their signal strength could yield information about the lower ionosphere. Observations on long and medium-wave stations in Scandinavia were taken to obtain the variation of radio-wave absorption during the eclipse and give information about the 'E' and 'D' layers. The short-waves came in for two classes of observations as follows:—(1) Stations in U.S.A., Canada, U.S.S.R. and South Africa were closely observed as to the variation in their signal strength during the eclipse and further information about "F_2" layer could thereby be obtained. The transmission paths of American and Russian stations passed near the track of totality while those of African stations remote from this served as a check upon the eclipse variations. (2) Stations in Norway and Sweden which were at shorter distances from Britain were observed for the variation in their signal strength.

The ultra short-wave stations were also observed for the "bursts" (sudden returns of energy from the upper regions lasting for a few seconds) to find out whether these were subject to a certain degree of solar control. Some observations were also made by direction-finding apparatus on stations laying far to the West, the East and the South of Britain to find out whether the incoming radio signals were diverted from their true great circle course due to the effect of the eclipse.

It is expected that the obsrvations when analysed thoroughly will contribute greatly to the phenomenon of radio-wave propagation on all wave-lengths.

S. P. Chakravarti.

WANTED A MUSEUM OF EVOLUTION

INDIA is a country steeped in ignorance, with her population sinking in a morass of antiquated ideas and ancient superstitions. Reactionary forces under the garb of religion keep the people in a state of virtual civil war, and riots take place on the flimsiest pretexts. How can we prevent this internecine communal warfare? Various remedies have been suggested from time to time but without much success. This problem like others has many facets and should be attacked from many sides and all remedies suggested by intelligent people should be tried. The root-cause of the trouble appears to lie in people attaching too much importance to religion which to most of them means ritualism and recitation of incomprehensible verses from religious books. Only a sutdy of Biology can broaden people's minds, so that they may realize that primarily they belong to the species *Homo sapiens* and they are human beings first, and Hindus, Moslems and Sikhs afterwards.

Biology is a revolutionary science, which changes an individual's outlook on life as no other science does. There is a common misconception that Biology is merely a study of leaves and flowers of flowering plants, and of the bones of dead frogs and rabbits. A person who has never looked through the microscope at amœbæ and paramæcia wriggling and rolling at diatoms and desmids with their beautiful symmetrical shapes, the fine lace-like structure of the stem of a herb, and at the patterns of chromosomes in the dividing cell, may be excused for his ignorance. The microscope has revealed a new world, which is infinitely more beautiful and with such variety in shape and form that it surpasses all imagination. A layman who has not studied the mechanism of reproduction in plants cannot imagine that they too have sex, and some like ferns, Cycas and Ginkgo, have living motile sperms as in animals. In fact, a biologist looks at plants and animals with a different eye, and the vision of living beings, which he acquires by study and observation, greatly broadens his outlook on life and the universe. The study of heredity and evolution reveals an orderly universe, in which the whims and idiosyncrasies of gods and their miracle-working apostles have no place. A study of evolutionary Biology serves as a solvent of religions, dogmas, superstitions and misconceptions, which we so laboriously pile up in the primæval atmosphere of our Indian homes. It is only by a study of Biology that the so-called inherently religious Indian people will drop their religious blinkers and begin to see the world in the cold and clear light of science, liberated from the thraldom of superstition.

How can we bring the knowledge of Biology to the common man? I suggest that we should open "Museums of Evolution" in the public parks of all the university towns of India. At least we should make a start by opening such museums in centrally situated towns like Delhi and Allahabad. Parties of students should be invited from all the schools served by the university concerned and given lectures in Hindustani on the evolution of life and its significance, in these museums. A programme can be arranged on a provincial basis for all schools served by a particular museum, so that these institutions and their staff remain busy all the year round.

A "Museum of Evolution" is not a Natural History Museum in which all types of animals, dead or fossilized, are preserved. In a "Museum of Evolution" only those animals and plant types which have any evolutionary significance can find a place. It is a museum whose primary function is educational. In a "Museum of Evolution", the evolutionary history of 'Life' through the various geological epochs should be pictorially shown by means of mural paintings, charts, models and specimen of animals and plants of evolutionary importance. We can also show the process of evolution in the inorganic and organic world by means of models, *e.g.*, the evolution of atoms from electrons and protons, of molecules from atoms, and of colloids from molecules. The evolution of the planetary system from gaseous matter of a Nebula can also be shown by means of models.. Then we can show the progress of life through the ages from unicellular Algæ and Protozoa to Cœlenterates, Fishes, Ferns, Amphibia and Lycopods, Reptiles and Gymnosperms, and Mammals and flowering plants to Man and the present-day vegetation, by means of mural paintings, clay models and charts. The radiation of phyla of various plants and animals can be shown on a cone-like structure. Fossils of ancient plants and animals should also be shown, and in the case of rare missing links like *Archœopteryx* and fossil horses, plaster casts obtained from geological mueums of Europe and America can serve our purpose. We can also show the evolution of limbs, skeleton, ears, eyes, brain, heart, kidneys and sex organs from worms to Man by means of models.

A Portrait Gallery of Evolutionists

A separate room should be reserved for the portraits of eminent thinkers who have discovered the theories and facts of evolution and have militantly spread the idea in face of opposition from so-called religious people, Lamarck, Erasmus Darwin, Charles Darwin, Wallace, T. H. Huxley, Hæckel, Weissmann, Julian Huxley, and H. G. Wells, will inevitably find a place in such a portrait gallery of Evolutionists, and below their portraits, a gist of their works should be given for the benefit of the visitors. In such a Museum, a Library of all available books on Evolution should also be maintained, and pictorial cards and illustrated books on the subject of evolution should be sold to visitors at cheap prices. Bible societies provide free copies of Bibles to heathens when they visit the countries of the West, while on the other side, we see that no attempt has been made in this country to provide even cheap literature on a subject of such great importance as Evolution, which affects man's outlook on life so fundamentally. Cheap stereo scopic picture-books, fitted with the usual red and blue celluloid orthoscopes, showing various geological landscapes and forms of life prevalent in those periods, can be produced at democratic prices for sale to visitors. Cheap

picture-postcards of useful evolutionary charts, fossil animals and plants, and eminent evolutionists and biologists with brief descriptive notes should also be produced for sale to students and visitors at cost price. Films showing a reconstruction of evolutionary progress of life should also be shown in these museums. Walt Disney, in his *Fantasia*, has shown us a film which can be suitably modified for educational purposes. We should diffuse the knowledge of the theories and facts of Evolution among the masses thus rousing them from their age-long sleep. It we can get the services of mural painters like Diego Rivera and Orzoco, we should also venture into the facts of social evolution, showing the march of humanity from the primitive society of the Paleolithic period, through Pastoral, Agricultural stages, and Feudalism, Mercantilism, to Capitalism and ultimately to Socialism under the impact of Technology.

Such "Museums of Evolution" should have a prominent place in our post-war educational programmes and plans. This is an age of visual education, and the plan of museums of Evolution with mural pictures, models and specimens, which we have outlined above, all serve as a better medium of instruction as compared with scores of schools and colleges. School teachers and students, who would come from all over the countryside to these museums, will become apostles of science and culture and will play an important role in educating India and in producing a generation of enlightened and cultured people, who will be able to hold their own in the vanguard of world progress.

M. S. RANDHAWA.

PROF. OTTO HAHN

PROFESSOR OTTO HAHN, who has been awarded the Nobel Prize in Chemistry for the year 1944, is a distinguished worker in the field of radioactivity. He has to his credit the discovery and isolation of several radioactive elements, as also the now well-known phenomenon of nuclear fission. Born on the 8th March 1879, he started his career as an organic chemist in an industrial concern and quitted this early to take up the study of the chemistry of the radioactive elements, being impressed by the outstanding work of Madame Curie and Rutherford. Working at first under Sir William Ramsay in the University College, London, he studied the activity of thorianite and isolated radio-thorium. In 1905, he proceeded to Montreal to work in Rutherford's laboratory and discovered radio-actinium. Returning to Berlin to work in the radioactivity section of the *Kaiser Wilhelm Institut Fur Chemie* (of which, later, he became the Director), he discovered mesothorium and perfected a method of separating radioactive products, using the recoil phenomenon. When he was elected to the Prussian Academy of Sciences in recognition of these researches and referred to his good fortune in working with men like Ramsay, Soddy and Rutherford, the President of the Academy naively remarked, "In science we very often find work without luck, but never luck without work". It will be interesting to recall that at a meeting in Bangalore some years ago to honour Sir C. V. Raman on his receiving the Nobel Prize, the Chairman, Prof. H. E. Watson, made a similar remark, "Accidents come to only those who look for accidents".

In the year 1918, in collaboration with Fraulein Lise Meitner, Otto Hahn discovered protoactinium, the immediate radioactive parent of actinium. They also came across the first example of nuclear isomerism in studies of the disintegration of uranium. With v. Baeyer and Meitner, Hahn showed by means of a magnetic analysis that the internal conversion electrons associated with gamma-rays always consist of perfectly homogeneous groups. When the idea of the possible existence of elements of atomic number higher than that of uranium was being put forward by Fermi, based on experiments on neutron-irradiated nuclear reactions carried out by him and his collaborators in Rome, Irene Curie and Savitch in Paris and Hahn and his co-workers in Berlin, set out to examine the products formed by the entry of the neutron into the uranium atomic nucleus, to confirm Fermi's conclusions. Actually, the searching chemical analyses of Hahn and Strassmann revealed that short-lived isotopes of barium and lanthanum are formed when neutrons bombard uranium. In announcing these unexpected results in the columns of *Naturwissenschaften* of 6th January 1939, they wrote with a certain amount of trepidation, "Perhaps, after all, our results have been rendered deceptive by a series of strange accidents". Soon after this announcement was made, Lise Meitner and Frisch pointed out in the columns of *Nature*, that the entry of the neutron into uranium brings about the disruption or "fission" of the nucleus, into two lighter fragments of nearly equal mass and charge, flying apart with great energy. Further chemical investigations in Hahn's laboratory showed that xenon and strontium were the final products in the break-up of the uranium nucleus. On the 23rd July 1939 Prof. Otto Hahn gave a talk on these researches at the Royal Institution in London, as a special guest of the Royal Society. Prof. Niels Bohr who attended this meeting, on his way back to Copenhagen from U.S.A., gave an account of his theory of nuclear fission, on the basis of the liquid drop model of the atomic nucleus, put forward by him, sometime earlier. A more elaborate theory of the mechanism of fission was given subsequently by Bohr and Wheeler in the *Physical Review*. Further experimental work by F. Joliot in Paris and Glasoe, Fermi and others in U.S.A., established the phenomenon of nuclear fission and indicated that it may be brought about in other heavier nuclei as well, by irradiation with neutrons or in some cases with gamma-rays. In conclusion, it may be recorded that the investigations of Hahn and his co-workers are unsurpassed in the assiduity with which they have been carried out and the far-reaching developments they have led to.

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G. SURYAN.

RÖNTGEN RAYS, 1895-1945

BY S. RAMA SWAMY, Ph.D., F.Inst.P.
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IT is fitting that on this occasion of the commemoration of their discovery half a century ago, we should refer to X-rays by the name of their discoverer, even though such a terminology is now obsolete. WILHELM KONRAD RÖNTGEN discovered X-rays while operating a discharge tube in his laboratory at Würtzburg in November 1895. For this discovery of fundamental importance in physics he was awarded the Rumford Medal of the Royal Society in 1896 and the first Nobel Prize in physics in 1901. This discovery opened the gates to a vast new field of fundamental scientific and industrial research and placed a new and powerful tool in the hands of the medical man for the alleviation of human suffering. The vastness of the field and the fundamental nature of the discovery may perhaps be best realised by the statement that during the fifty years following the discovery, as many as seven Nobel Prizes have been awarded for discoveries in X-ray physics. Eminent men of science have since worked in this field making outstanding discoveries of a fruitful character some of which have been of much use not only in physics but in other branches of science and industry. The discovery of X-rays was not a matter of chance. Röntgen was looking for invisible radiations emitted by a discharge tube. For this purpose, he had on his table a small screen of cardboard coated with crystals of barium platinocyanide such as those used at the time in Germany for revealing the invisible rays of the spectrum. Röntgen carefully covered up the discharge tube with black paper and excited it to find out whether all light was excluded. To his intense surprise he found the screen shining brightly. This led to further investigations and the ultimate discovery of invisible radiation from the tube, to which he gave the name X-rays "for brevity". These rays were found to be emitted by the spot on the discharge tube bombarded by the cathode rays. Röntgen conducted further experiments and discovered that X-rays traverse matter opaque to ordinary light and that they affect the photographic plate. He announced his discovery in a paper presented before the Physik-Medic. Gesellschaft of Würtzburg in December 1895. This paper was subsequently reprinted in *Annalen der Physik* (64, 1, 1898). In this very first paper he anticipated many of the different applications of X-rays which have developed during the past fifty years.

X-rays are emitted by any material bombarded by cathode particles. In X-ray tubes a metallic target, known as the anti-cathode, is provided for this purpose. In so-called gas tubes cathode-rays produced by the discharge are focussed on the anti-cathode by suitably shaping the cathode. In hot cathode tubes the electrons emitted by the hot filament of the cathode are accelerated by the applied tube voltage. They are also focussed on the anti-cathode by surrounding the filament by a concentric metal cylinder, one end of which projects a little beyond the filament. X-rays are emitted from the focal spot on the target. In gas tubes it is necessary to maintain a residual gas pressure of the order of about 10^{-3} mms. of mercury for running the discharge. The hot cathode type of tube is comletely evacuated, degassed and sealed off. The tube voltage was generated by an induction coil in the early days. The high tension transformer is universally employed nowadays. During the past fifty years the application of X-rays in medicine, industry and scientific research has advanced very rapidly. Advance in the design and manufacture of X-ray apparatus has kept pace with the rapid advance in the application of X-rays. The range of apparatus commercially available is considerable, each type serving a specific purpose. X-ray tubes employing voltages of the order of millions are in regular use particularly in America. One such was developed by the Massachusetts Institute of Technology and is installed at the Huntington Memorial Hospital of the Harvard Medical School. Another one, thirty feet long and weighing ten tons, is in use in the Mozelle Sasson High Voltage X-ray Therapy Department of St. Bartholowew's Hospital, London.

The use of X-rays for diagnostic purposes in medicine was the first to be realised. Within a very short time of their discovery, they were successfully employed for diagnosing a diseased thigh bone in Paris, for observing the reunion of a fractured bone in Berlin and for the location of a bullet lodged in the calf of a patient in America. For diagnostic purposes, the X-ray shadow of the subject is observed on a fluorescent screen or alternatively photographed for obtaining a permanent record. Such a photograph is known as a radiogram, the technique itself being known as radiography. Radiography is a routine in many medical institutions nowadays. Bone and such other dense material throws deeper shadows than surrounding tissue so that the radiologist can, as it were, look inside the body of the patient.

Radiography is also in general use in industry, particularly in Europe and America. The detection of flaws in weldings, pressings, forgings and castings and also the inspection of assembled articles like radio valves, fuses and so on by radiographic methods is a matter of routine in many factories. This method is invaluable in the aircraft industry. Radiograms are often of great help to fine art for scrutinising works of art reputed to be ancient.

After the discovery of diffraction of X-rays by crystals in 1912 by Max von Laue, great advances were made on the investigation of the nature of X-rays on the one hand and the fine structure of matter on the other. Röntgen was of opinion that X-rays are waves due to *longitudinal vibrations* in the so-called luminiferous ether. Some physicists, mainly British,

thought that they were corpuscular like cathode-rays. But Laue's discovery definitely proved that X-rays are electromagnetic waves similar to light. Their wavelength lies in the range of about 0·06 to 500 Å. The work of Barkla, Mosley and others has shown that the X-rays emitted by the anti-cathode of an X-ray tube are of two types, *viz.*, the continuous radiation and the characteristic radiation. The continuous radiation consists of all wavelengths above a short-wave limit which itself is dependent on the voltage applied to the X-ray tube. The characteristic radiation consists of monochromatic radiation characteristic of the element of the anti-cathode. Every element has its own characteristic X-ray spectrum and X-ray spectroscopic methods have been developed for the analysis of any given material. Such methods led to the discovery of Hafnium by Hevesy and Coster in 1923. A systematic study of X-ray spectra has gone a long way towards the elucidation of atomic structure.

The diffraction of X-rays by crystals has led to the systematic study of the solid state of matter. The structures of a very large number of crystals have been determined resulting in the comprehension of many phenomena connected with the solid state of matter. Among outstanding workers in this field may be mentioned the late Sir William Bragg and his school.

X-ray crystallographic methods find a large number of applications in industry like the measurement of stress in castings, pressings and forgings. Many problems confronting the metallurgist like thermal equilibrium, internal stress and strain, crystal texture and phase identification may be solved by simple X-ray crystallographic methods. The development of these methods has advanced to such an extent as to warrant the organisation of Industrial X-ray Conferences by the Institute of Physics.

Systematic work on the biological effects of X-rays was stimulated by the discovery that continuous irradiation produces a disease known as X-ray dermatitis. X-ray irradiation in proper doses inhibits the growth of living cells in tumours. But prolonged exposures may produce proliferation of cells resulting in cancer. Some of the early X-ray workers became victims to such disastrous biological effects. Recommendations for adequate protection from such effects have been drawn up and published by the International Congress or Radiology. The biological effects are made use of in the treatment of certain types of tumours and skin diseases. X-ray irradiation is also known to produce mutations of chromosomes in certain cases.

Even from a casual survey of the past half a century of X-ray work, one cannot help finding that there are very few branches of human knowledge and experience which have not felt the impact of the developments of applications of X-rays. It is not too much to hope that their applications to the advancement of human knowledge and the alleviation of human suffering may multiply a thousand-fold.

A LARGE-SCALE YIELD SURVEY ON COTTON

By V. G. Panse,[1] R. J. Kalamkar[2] and G. C. Shaligram[1]

SINCE 1942-43 studies have been in progress on cotton for evolving a suitable method on a random sampling basis for forecasting and estimating the yield of the commercial crop. These have led to extensive developments, and not only has one large-scale survey on cotton been successfully carried out in the Central Provinces last year and another proceeding in the current season, but similar large-scale surveys on the principal food-crops, wheat and paddy, have been completed (Sukhatme, 1945) and are being conducted in different provinces by the Imperial Council of Agricultural Research. Within a short space of time, an efficient practical tool has thus been made available for measuring with precision the yield of crops covering millions of acres. The object of the present article is to describe the yield survey on cotton conducted during the season 1944-45 in Central Provinces and Berar. This survey, which has spread over 29,342 square miles and covered nearly three million acres of cotton, provided for the first time the means of estimating the average yield per acre and total production of cotton in the province by a scientific objective process.

For a proper appreciation of the sampling technique adopted, it will be useful to describe in broad terms the structure of a province in India. A revenue district is the major administrative unit in a province, and a province usually contains 20 to 25 districts. The geographical area of a district is about 3,000 sq. miles. A district is divided into four or five *tahsils* or *taluqs*, each with an area of 600 to 800 square miles and containing roughly 400 to 500 villages. A *tahsil* is further divided into three to five circles for the convenience of the revenue administration and a circle contains about a hundred villages. A Revenue Inspector is stationed in each circle. Communications between villages are poor. Good metal roads are few and far between and most of the villages are only accessible by a cart track. The revenue map of a *tahsil* with the village boundaries marked on it looks like a honey-comb with the villages forming the cells of this comb. The map of a single village reproduces the same pattern with individual fields forming the cells. Complete lists of villages in each *tahsil* or in each circle are available with the Land Records Department. The area of each field is accurately measured periodically and recorded in the villages. Except in provinces like Bengal and Bihar with a permanent land revenue settlement, there is a village accountant or *patwari* for each village or a group of villages and one of his principal

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duties is to make a complete seasonal enumeration of area under different crops by an inspection of fields within his jurisdiction. It is this unique feature of the land revenue administration in India which imparts to the figures for annual crop acreages in most provinces a degree of accuracy unequalled in any other country in the world.

Such a framework lends itself excellently to the application of stratified random sampling. The *tahsils* form relatively homogeneous and compact subdivisions of the tract to the surveyed, and villages and fields provide the principal and secondary sampling units. A strictly random selection of the sample villages within a *tahsil* can be made easily from the village list and a similar random selection of fields within a village also presents no difficulty as the list of all fields growing a particular crop in the selected village can be readily had from the *patwari*. The selected fields can be sample-harvested by locating one or more plots of a suitable size in random positions.

From two pilot surveys described earlier in this *Journal* (Panse and Kalamkar, 1944 *a, b*), the first carried out in Akola district in 1942-43 and the second in Akola and Buldana districts in 1943-44, it was found that if some 200 villages were sampled over the whole cotton tract of the province and four fields sample-harvested in each selected village, the provincial yield would be estimated with a standard error of 3 per cent. or less. This expectation as will be seen later, was borne out in the present survey. It was also found that the harvesting of a plot of 1/10 acre size, with which both the district land records staff and the farmers are familiar because of its adoption in the departmental crop cutting work, was quite satisfactory on the ground of practical convenience, as any change in plot size from 1/20 acre to 3/10 acre did not lead to a material change in the accuracy of the final yield estimates. It was, moreover, sufficient to harvest only one such plot per field as variation within a field was found to be quite small compared to the variability between fields.

The plot size may be made somewhat smaller in a tract where the yield level is higher; but very small plots, say 10 or 12 square feet in size, like those adopted by other workers (Hubback, 1927; Cochran, 1939; King and others, 1942) in surveys on cereals are obviously unsuitable for cotton where the harvest is gathered in five or six rounds of pickings spread over a period of three or four months. The use of such small plots in other crops also is beset with difficulties, both statistical and practical, from which the large plot is mostly free. In spite of its limitations the small plot seems to be adopted by workers in England and America on the grounds of convenience and economy; but it cannot necessarily claim the same advantage in India. The relationships between the availability and cost of field labour on the one hand and of transport and travelling facilities on the other are entirely different in the two cases.

The present survey included all four districts in Berar and three other districts, Nimar, Wardha and Nagpur, and three more *tahsils*, one each from the districts of Hoshangabad, Chanda, and Chindwara, from the rest of the province. It was carried out in 34 *tahsils* in all and sampled 99¹/₄ per cent. of the total cotton acreage in the province. A total of 204 villages were randomly selected in these 34 *tahsils*. In assigning the number of villages to each *tahsil*, two points need to be considered. The first is that the number of villages per *tahsil* should be in proportion to the cotton acreage in the *tahsil* in order to attain maximum accuracy in the provincial estimate of yield. Secondly, it is necessary to estimate the average yield of each district within a reasonable margin of error, as this yield figure is used administratively and forms the basis for calculating the normal or standard yield for the district. The latter condition requires that a certain minimum number of villages must be selected in each district irrespectve of its cotton acreage. As a comparison between these two considerations, the following scale was adopted for the selection of villages in the present survey.

Area under cotton in the tahsil	No. of villages selected per tahsil
Less than 50 thousand acres	4
50–120 ,,	6
120–130 ,,	8
above 139 ,,	9

A somewhat larger total number of villages than the number available in the present survey needs to be selected for a more satisfactory distribution according to the cotton acreage. The number in the present survey was restricted by the factor that the fieldwork was to be done by a wholetime temporary staff of fieldmen, each in charge of a group of three or four villages, and travelling between villages had to be kept down to a minimum.

In each village, four cotton fields were randomly selected and a plot of 1/10 acre (33′ × 162′) was marked in a random position in each field and harvested. The produce was weighed by accurate iron beam balances and standard weights supplied to fieldmen, as the village balances and weights are unreliable, and the local weights, moreover, have widely varying connotations. The results of the survey are summarized in Table I.

The average yield per acre for the whole province was determined with a standard error of 2·9 per cent., and an error of this magnitude was predicted when the present survey was planned. The average yield per acre in different districts had a standard error ranging from 5 to 11 per cent. A somewhat higher standard of accuracy of the district estimates is clearly desirable, and the number of villages per district must be increased in future surveys, with a view to attain a standard error of the district estimates of yield as near to 5 per cent. as possible.

The official yield figure for the whole province was 192·6 lbs. of seed-cotton per acre

TABLE I

Yield per acre and total production in different districts

Name of district	Cotton area (thousand acres)	No. of villages selected	Yield of *kapas* (seed cotton) lbs. per acre	S.E. per cent of yield	Total production in bales of lint (1 bale = 392 lbs. lint)
Buldana	469·1	30	194·6	7·8	79154
Akola	561·1	38	195·0	5·5	92810
Amraoti	552·1	33	143·6	8·6	65292
Yeotmal	511·8	39	207·2	5·4	89003
Total Berar block	2094·4	14	184·6	3·3	326359
Nimar	238·4	18	158·3	7·0	28556
Wardha	269·6	18	137·2	10·9	31272
Nagpur	108·0	16	123·6	10·8	11417
Harda (*tahsil*)	7·8	4	98·9	16·7	654
Warora (*tahsil*)	33·5	4	122·5	23·3	3251
Sausar (*tahsil*)	22·8	4	141·6	6·8	2816
Total C.P. block	675·4	64	141·3	5·4	77966
Whole province (C.P. and Berar)	2769·8	204	174·1	2·9	404225

according to the final forecast. It was 10·6 per cent. higher than the survey estimate, and the excess being more than twice the standard error of the survey estimate should be taken to be real. The excess in the separate blocks, Berar and C.P. was of the same order. The official overestimate has to be mainly attributed to a significant excess of 39·6 per cent. in Amraoti district and of 23·1 per cent. in Nimar district though the official figures were slightly higher than the survey estimates in most districts. It should be recalled that in 1943-44 when yield was much higher, and the survey estimates were 282 and 299 lbs. per acre in Akola and Buldana districts, the official figures were lower by 10 and 17 per cent. respectively. The tendency in the official forecasts to underestimate good crops and overestimate poor crops is well brought out by the survey results for the past three years.

The total production for each district and for the whole province is shown in terms of lint in the last column of Table I. Conversion of seed-cotton into lint involves the use of a factor for ginning outturn. The usual procedure is to adopt a conventional figure of $33^1/_3$ as ginning percentage. Its use, however, might introduce an error and possibly a bias in the estimated total production of lint, as the ginning percentage is known to vary according to the season and the variety of cotton. It was found, in the year 1943-44, for example, that the variety Jarilla (*G. arboreum* var. *neglectum*) ginned by the agricultural department gave a ginning outturn as high as 37½ per cent. The rapid spread of this variety, which is growing in popularity, is bound to raise the average ginning outturn of the cotton tract in the province. For these reasons an attempt was made through the provincial department of industries to obtain ginning outturn data of the commercial crop of the season from owners and operators of ginning factories located in the cotton tract. Out of 82 factories addressed, apparently reliable information was secured from 61. From these data, ginning percentage values, appropriately weighed according to the quantity ginned and varieties, were calculated for almost every *tahsil* for conversion of seed-cotton production into that of lint. The ginning percentage values ranged from 29·7 to 34·9 in different *tahsils* and were generally higher where the variety Jarilla was dominant.

For the area covered by the survey the total production was thus estimated at 404,225 bales of lint as shown in Table I and this estimate is subject to a standard error of 11,456 bales. The area was, as stated earlier, 99¼ per cent. of the total cotton acreage. Extending the calculation to the full 100 per cent. area, the estimates of total production and its standard error were altered to 406,558 and 11,664 bales respectively. From the official estimates of the yield of *kapas* (seed-cotton) per acre and a ginning outturn of $33^1/_3$ per cent., the total production for the whole area was calculated at 456,681 bales or 12·3 per cent. must be counted to be in significant excess. If actual ginning percentages found from factory data were employed to convert the official yield figures for seed-cotton into lint, the official estimate for total production would be reduced to 449,148 bales and would then be higher than the survey estimate by 10·5 per cent., the excess still being significant.

Apart from its principal function of providing reliable yield estimates, the sampling survey can be utilized to obtain a considerable amount of ancillary information of great practical and scientific value. On certain topics, the survey is the only means of procuring representative data. A variety of useful data were collected in the course of the present experiment and are under examination. Space would not permit us to do more than make a brief reference to one or two items here.

The variety of cotton grown and its condition of purity were carefully observed in all selected fields, in order to assess the spread of improved varieties in the cotton tract. In this respect Berar was found to be in a distinctly better position than the rest of the province. Jarilla was practically the only variety grown in Buldana district, and in Akola district too, the varieties Jarilla and Verum (*G. arboreum* var. *neglectum*) accounted for nearly 90 per cent. of the fields. In Amraoti, besides Jarilla, 30 per cent. of its cotton area was under Buri (*G. hirsutum*), an improved American Upland variety. In the rest of the province, most of the area was found to grow unselected indigenous cotton (*G. arboreum* var. *neglectum*), ecepting Nimar district which had most of its area under improved varieties including 40 to 45 per cent. under Buri. This summary of the spread of improved seed has, however, to be qualified by the observation that a considerable degree of admixture was found in the fields. For example, only about 25 per cent. of the fields under Jarilla had a pure or a nearly pure crop of this variety. The Upland variety Buri was found to be purer in that about 65 per cent. of the fields with this variety were found free from admixture with indigenous plants.

Cotton is grown in the province mostly in mixture with other crops, chiefly *tur* (*Cajanus indicus*), the usual practice being to sow a few lines of *tur* at intervals among the cotton rows across the whole field. In calculating the net area under cotton an allowance is made for the areas occupied by these other crops. In Berar, the *patwari* directly records the net areas of cotton and of other crops in the field by eye appraisement while in the rest of the province numerical factors are prescribed for converting the gross area of cotton mixtures, which is recorded, into net area under cotton. To verify the soundness of this procedure and examine the accuracy of the allowance made for crops grown mixed with cotton, actual counts of rows of cotton and other crops were made in the fields selected for the survey. The analysis of these counts showed that the allowance made by the current procedure is substantially correct. No significant discrepancies were found in Berar, and in other districts also the conclusion was that only in areas on the periphery of the cotton tract, the extent of the mixture of other crops in cotton was probably underestimated.

The problem of improving yield forecasts from the standing crop is also being studied and eye estimates of the crop of the selected fields and quantitative observations on stand, number of bolls and boll weight, in small sample areas in the plot are recorded for comparison with the actual yield. The object is to determine how far eye appraisement alone can be relied on or whether it has to be supplemented or even replaced by quantitative observations. The possibility of a further improvement in the yield forecast made at the beginning of the harvesting season from a knowledge of the yield of the first picking is also being examined.

On the technical side, valuable information on the optimum number of samples and their distribution can be obtained from an analysis of the survey data. The methods employed for this purpose have been indicated in an earlier article (Panse and Kalamkar, 1944 *a*). The analysis of variance of the plot yields in the present survey showed that variability between villages was 1·56 times the variability between fields within villages in Berar districts, and 1·32 times in C.P. The two analyses were made separately because the variation both of fields and of villages was appreciably higher in Berar than in C.P. In the two previous seasons' surveys in Berar, the ratio of variation between villages and fields ranged from 1·4 to 1·8, and was thus of the same order as that observed in the present survey though the absolute variability of villages and fields differs appreciably in different seasons and in different tracts.

The number of villages and the number of fields per village required to be selected for securing yield estimates for the whole tract with a given degree of precision were calculated from the present results and are shown in Table II.

TABLE II

Number of villages and standard error of mean yield

No. of fields per village	No. of villages and standard error of mean yield					
	Berar results			C. P. results		
	1% s.e.	2% s.e.	3% s.e.	1% s.e.	2% s.e.	3% s.e.
3	2216	554	246	1786	446	198
4	1825	456	203	1425	356	158

Previous surveys had yielded numbers of the same order of magnitude. The actual numbers obtained from different surveys would naturally differ to some extent both on account of real differences in variability and the sampling errors to which these numbers are subject. The present figures are found to have sampling errors of 15 and 18 per cent. in Berar and of 20 and 24 per cent. in C.P. It is rather clear from the three years' results that sampling on a scale sufficient to attain a standard error of 1 per cent. of the average yield is not a practical proposition in cotton. This low error can be reached in surveys on cereals (Sukhatme, 1945); but cotton is obviously more variable, and a standard error of 2 to 3 per cent. is all that can be aimed at. Experience in U.S.A. is similar (Sarle, 1932).

The ultimate goal of the present surveys is the introduction of the random sampling method as a permanent feature in the estimation of crop yields. The fieldwork of the surveys will have to be done by the existing departmental staff as the employment of any large permanent staff for this work alone seems out of question. Equipped with the technical experience of the past three years, we are now in a position to study the organizational phase of the problem, and this aspect has been given primary consideration in planning the provincial survey in C.P. and Berar for the current season. The temporary staff

of wholetime fieldmen employed previously has been dispensed with and the fieldwork is entrusted to the locally stationed district staff of the Land Records Department. For administrative convenience and a more even distribution of work, the revenue circle has been adopted as the unit for sampling in place of the *tahsil* though this change is not likely to lead to any further increase in statistical accuracy of the yield estimate. Two villages per circle where the cotton area is below 20,000 acres, and three for higher acreages is the scale of sampling adopted. This modification has resulted in the selection of a large number of villages, 335 against 204 in the last year, and made possible their distribution in proportion to the cotton acreage. The increase in the number of villages will be advantageous for both reasons. There are three fields under experiment in each village and the experiments in each circle are in charge of the Revenue Inspector of the circle. The supervising staff for each district also belongs to the department. The projected survey will be watched mainly to test the working efficiency of the organization, to detect its possible shortcomings and devise suitable remedies for these. With its conclusion the end of the experimental stage will be reached, and we may then expect with confidence that the provincial administrations will undertake yield surveys on this plan under technical direction as an annual routine.

The survey described in the present article was financed by the Indian Central Cotton Committee. It is a pleasure to acknowledge the wholehearted co-operation and encouragement given by Mr. M. I. Rahim, I.C.S., first as Director of Land Records, and later as Commissioner of Berar, and Mr. B. A. Bambawale, I.C.S., the present Director of Land Records, in the prosecution of this experiment. The initiative and hard work of Mr. N. N. Bhide, who was in charge of the fieldwork, was responsible for its satisfactory completion.

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RIVER FLOOD CONTROL*

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Nature and Extent of the Problem

ALL over the world the problem of combating the destruction and damage caused by river floods is confronting the engineering profession. From the earliest times China has been affected by the floods of the Hoango and the Yangtse, as also our own mother-country, India, particularly parts of Bengal, Bihar and Orissa on the east, and the Indus Valley on the west coast. The Continent of America has figured largely during the last two centuries or so, where the engineers have been constantly at work during this period trying to tame the mighty Mississipi and other rivers. In the Continent of Europe flood protection works have been carried out during the last six or seven centuries, especially in Spain, France and Russia. In no country finality has yet been reached.

Fortunately, the State of Mysore, being situated on a plateau, is practically immune from inundations of rivers and consequent damages, though here and there are some towns which are affected to a small extent by floods. However, it behoves us as engineers to study this world-wide problem and keep ourselves abreast of the work that is being done by the engineering profession abroad. My object in reading this paper is thus to stimulate study and research by the members of this Association, some of whom may in future years be called upon to tackle flood protection works.

* Paper read before the Mysore Engineers' Association at their Conference held in 1945.

II. Collection of Essential Data

2. The first thing to be done in devising measures for river flood control is the collection of data under several heads, such as

(1) rainfall statistics in the catchments of the rivers extending from the head to the mouth for as many years as may be possible and for as many stations as are available;

(2) study of the topographical features of the catchment and the climatic conditions, and preparation of maps showing the areas affected by floods at different stages of the rivers;

(3) gauging of river flood discharges at vital reaches and correlating them to the rainfall and comparing them with calculated discharges based on river sections and slopes or with the recorded flow over weirs or at bridges;

(4) the extent and nature of damages caused from time to time, the population affected and the average annual loss caused to the people, the government, public utility companies, etc. This information has to be separately collected for urban and rural areas.

The study and collection of data should be a continuous one extending over several decades. This is especially so with regard to the calculation of flood discharges. It may be mentioned as an example that, in the case of the Mississipi river in America, a Special Commission was constituted by the Federal Government nearly four score years ago, and it has

been sitting since then collecting necessary data and carrying out measures for protection from time to time, but yet no complete protection has been afforded. Records of flood discharges show that anticipations made in the earlier years have been far exceeded by the actual flow in later years. It is stated by a certain authority that in the case of big rivers the highest floods occur once in a century or two or even at longer intervals. When data extending over longer periods are not available, some kind of forecast based on other similar rivers has to be made. After comparing discharges of the various rivers in the United States, one Mr. Weston Fuller has shown that the great floods of each river bear certain definite relations to the average annual floods on the respective streams. From these ratios he has deduced the following table showing the frequency of maximum floods of different magnitude:

Time in years	Ratio of maximum to average-hour flood-rate
5 ..	1·6
10 ..	1·80
25 ..	2·12
50 ..	2·36
100 ..	2·60
500 ..	3·16
1000 ..	3·40

These ratios cannot, however, be successfully applied until the average can be determined fairly approximately and they should be used only to supplement the local data.

III. Causes of Floods

3. The causes of floods and the factors affecting the intensity of floods have to be found before suitable remedies can be applied. Flood discharges vary a great deal, depending upon the intensity and duration of rainfall, the size, shape, topography and the geology of the catchment, the extent and nature of forest growth, climatic conditions of the region, etc. Floods of great rivers are caused by general heavy rains of considerable duration and also, more or less, by a series of local storms. If a watershed is long and narrow, it may have a less rate of flood run-off than if the catchments were circular or fanwise. Basins with very gentle slope serve more or less as detention reservoirs, while those with steep slopes bring about rapid floods. When slopes are gentle and the rainfall is of low intensity, the rain water is absorbed by the soil to a larger extent than otherwise; when the soil is of sandy and gravelly nature the percentage of absorption is still greater. Surface vegetation is also another factor moderating the intensity of run-off. The existence of natural lakes and ponds brings about greater uniformity of flow and reduction of the peak floods. Though afforestation or deforestation may not affect floods very materially, the former reduces the rate of run-off, while the latter tends to increase it.

The discharges derived from rainfall records have to be verified by actual river gaugings at selected reaches. A hydrograph showing the daily flow throughout the year and extending over a number of years will be found of great use. A proper block survey of the tracts affected by floods should be made and the areas actually flooded at different stages of the river above the bank-ful stage clearly indicated on the maps.

Inundation of marginal lands is caused by the river flow over-topping the banks on account of the undue silting of the river-beds, which, in deltaic country, are found to be higher than the marginal lands. The raising of the river bed has often been the result of sufficient waterway not being available in the river to carry the heaviest floods which thus spill over the banks. There is a definite relation between the quantity of water flowing in, and the silt conveyed by, a river. If the volume of flow is reduced by spilling, the silt is deposited on the bed resulting in the rise of the bed level. The waterway being thereby reduced further, succeeding high floods have necessarily to spill over the banks more and more and the tendency for the bed to silt up increases from year to year. The marginal lands are scoured by the floods spilling over and their level gets gradually lowered and subsidiary river valleys deeper than the original river are thus formed. This is how in deltaic regions the main rivers are generally found to be higher than the marginal countryside and a number of new rivers are formed—lower than the original river, which may die out in the course of centuries.

It is thus obvious that, in a system of works designed to prevent damages by floods, wherever possible, the original river should be made to function. Levees will be of use in making the rivers carry more water and silt than they can without such aid and clear their own beds. The quantity of silt carried by a main river will not be transported in full when it breaks up into two or more branches. Such breaking up should be prevented if the main rivers should remain in an efficient condition.

Sometimes it is found that floods are caused by encroachments on the natural waterway of rivers by structures artificially raised in towns and cities, authorisedly or unauthorisedly, or by railway and road embankments and such other works interfering with the river courses. It is most desirable that when any flood protection work is undertaken, a system of control on the construction of buildings, towns, factories, or other structures, etc., along river banks should be effectively enforced. Without such control it will soon be found that protection afforded at heavy cost will be nullified by unauthorised encroachments.

IV. Measures for Protection

5. When full data have thus been collected measures for protection can be designed. These measures may be grouped under three heads:

(1) Flood prevention,
(2) Flood diversion and
(3) Flood protection.

Under the first head will fall reservoirs and detention basins, afforestation, etc.

Flood diversion involves temporary or permanent diversion of peak floods from places along rivers where harm is likely to result to other places where a flood is less objectionable or to a valley which can carry the extra floods safely.

Under the third head are included levees, river channel improvements, such as, cut-offs, enlargements, etc.

It has been found by long experience in America and elsewhere that no single method can give hundred per cent. protection against floods. A thorough examination of every possible method of solution has to be made and conclusions reached after a full consideration of all the factors. The question in each case will be, not which method to apply, but how much of each will be most advantageous.

A study of practical measures adopted in many countries brings out the fact that there is a place for all remedies above mentioned. It may be generally stated that the best measure is the one that involves the least initial cost, reasonably low working expenses and that which most nearly fits in with popular ideas.

The expenditure involved should bear a reasonable proportion to the losses to be averted and the benefits to be secured. If the protection of big cities and industrial areas are involved, half-way measures will not do. The protection against floods must in their case be absolute and certain. If, however, only agricultural interests are to be protected, the aim should be more to prevent loss of life, both of men and animals, and serious damage to crops. In this case it may not be necessary to avoid flooding of agricultural lands altogether, as a certain amount of flooding of crops will not result in their total destruction, while there may be some advantage gained by partial flooding. The remedy need not, therefore, aim at complete protection, as in the case of cities and industrial areas, but only partial relief. The success of such protection has to be tested by the rapidity with which the farmers can rehabilitate themselves after an occasional crop loss.

Thus, after a full preliminary investigation of the several methods, it would be possible to eliminate or defer some of the more costly alternatives and confine detailed investigations to the cheaper remedies and save time and money.

6. I shall now offer a few brief remarks on each of the methods referred to above.

(b) *Flood Prevention.*—Storage reservoirs and what are called detention basins, afforestation, ground water storage and such like measures are included under this head. Storage dams, if built of the required capacity, have no doubt, the effect of moderating floods, *i.e.*, reducing the heights of extraordinary maximum floods. If reservoirs are to be effective against such floods, they must be kept empty in order that high floods may be absorbed at any time during the season in which such floods are expected. But if a reservoir is to be constructed for flood protection alone it will not be an economical proposition. It has, therefore, been usual with such schemes to combine generation of hydro-electric power or to improve the means of navigation along the rivers or to supply water for irrigation, for industrial purposes or city water supplies. Though these purposes are somewhat antagonistic to those of flood protection, if all these purposes are borne in mind when designing and sufficient capacity allowed for every one of the objects aimed at, a reservoir may be practicable. The design should be absolutely secure against any possibility of failure, as any such failure will result in a more disastrous flood than the one which the reservoir is intended to prevent. The situation of the dams has to be carefully selected, not merely with reference to its engineering and geological features, but also with reference to its distance from the flood-affected areas. Head water reservoirs will for example be of little use if the lowest reaches of the river are to be protected.

Detention basins are based on the principle of interpolating a high dam across a river with some openings in the structure constantly functioning. The idea of constant functioning is that the action will be automatic depending on nobody's discretion. Such basins are used in France. The effect of these basins is to retard the flow by partial absorption of high floods and to bring down the maximum to safe limits.

Ground water storage is secured by forming terraces in the catchment area and also by raising cover-crops which absorb rainfall to a certain extent, both of which will thus reduce the ratio of run-off. It is stated that these two methods have been adopted in the Tennessee Valley in America and they are found to absorb about four inches run-off on the catchment, proving a valuable supplement to storage by dams, the main means of control.

Coming now to the effect of forests on rainfall, I may say that there are conflicting views, one holding that forests act as equalisers of the flow of streams by diminishing in general the frequency of freshets and increasing the water flow in the non-rainy months. The other school holds that forests are of little or no benefit at all in respect of either. Such extreme views have to be avoided. There can be no doubt that the existence of forests will have a restraining effect upon run-off, ensure better regularity of flow in the high flood season and increase the summer flow. They also prevent erosion of steep mountain sides. The prevention of erosion is an important factor in any system of flood protection as erosion will result in undue silting of river beds, which is one of the main causes of destructive floods. The conservation of forest growth is, therefore, as necessary as any other measure of protection.

7. (c) *Flood Diversion.*—This method aims, as already stated, at temporary or permanent diversion of floods from places where damage is likely to result to less objectionable places. The diversions are effected by high level escape channels whether controlled or uncontrolled. The quantity of floods to be diverted has to be based on the carrying capacity of the river channel lower down and the safe pre-determined capacity of the escape channel. The head of the diversion channel should generally be located on the convex side of the stream and the velocity throughout the

channel must exceed the velocity in the section of the stream immediately opposite the diversion channel.

When not prohibitively costly, regulators should be provided to control the flow either through the diversion channel or the original river channel to the desirable or necessary extent.

Where the existing mouths of rivers are following a tortuous course or are blocked by bars, diversion is effected by opening fresh direct outlets to the sea. In such cases care should be taken to see that sea-water does not flow back along the river and flood culturable lands with salt water and make them unfit for cultivation.

IV. (*d*) FLOOD PROTECTION

8. The most popular and common method of protection against floods is *by means of levees or embankments.* This system has been extensively used in America. It has also been in vogue in India in several of the river deltas in Madras, Orissa and parts of Bengal. The construction of these embankments is generally attended with difficulties as they have to be formed by the soil obtained near about the river banks, which consists mostly of sand and silt. The material being porous the banks get saturated in high floods and slips may occur. They have, therefore, to be made broad enough and the slopes sufficiently flat and turfed or otherwise protected and maintained carefully. Percolation drains will have also to be provided. The heights of these levees are generally limited to about 20 or 30 feet.

The natural banks of rivers are subject to scouring action by the moving currents of water, and the artificial embankments are thereby endangered. In such places the banks have to be protected by stone revetment or, as in modern days, by flexible concrete mats. It may be found that this method may often be more costly than constructing new levees by retiring them to safer areas beyond the river margins. In towns and cities, however, such shifting may not be possible as acquisition of properties will be very costly.

Retired embankments are also provided when adequate waterway cannot be secured otherwise.

9. At one stage the Mississipi River Commission considered that the only safe solution for flood protection was by levees. But later experience has shown that they have not afforded the extent of safety desired or necessary and reservoirs have been found to be quite necessary along with other measures, such as diversion by means of spillways. The chief objection urged against levees is that when they fail they cause much greater damage than the natural river would have done by flooding marginal lands. This difficulty, however, is common to other remedies also, and on that ground the levees cannot be ruled out. At any rate all over they have taken precedence over other measures of relief, and have been more extensively used than any other means . Care should be taken in designing them properly with reference to foundations, nature of soil available for formation, duration and stage of high floods, the margin of free board to be allowed in the case of agricultural lands or in city limits, etc. When proper precautions are thus taken for making levees substantial and strong, failures can be minimised.

In city and urban areas masonry walls are generally built as they occupy less area than the earthen embankments and involve also less risk.

IV. (*e*) RIVER CHANNEL IMPROVEMENTS

10. I now pass on to river channel improvements which are generally combined with levees. Improvements are effected by increasing the sectional area of the rivers either by deepening or widening or by both and straightening river channels. Bends are eliminated by cut-offs and the channel surface is smoothened by removing obstructions. In carrying out the above measures the energy of the flowing waters during floods should be made use of to the maximum possible extent for clearing the dredged material or excavated spoil or enlarging pilot channels and such other processes.

At places where rivers divide themselves into branches the currents should be so guided that each branch takes its due share of the flowing water and of the proportionate sand burden. Regulators may be necessary at the forks and provided when cost can be afforded.

IV. (*f*) MODEL EXPERIMENTS

11. It is very desirable that model experiments should be conducted at special Research Stations and the effect of each kind of remedy tested. This is necessary because the effect of some of the improvements has been found in many cases to be very temporary. For example, dredging of hard spots proves effective for some time, but after a few years it is found that the silt and sand brought down from the higher reaches accumulate at the very place and soon make up a simliar obstruction. The same is the case with cut-offs. Unless the surface fall of the flowing waters is increased right from the point of the first cut-off down to the mouth, the effect of individual cut-offs will be found to be local. This is due to the fact that while the flow line level above the cut-off is increased in slope, that below is reduced, unless the next cut-off downstream and the next and so on are tackled in series. The study, therefore, by means of experiments will demonstrate the success or other of the remedies proposed. The cost of such experiments will be a trifle compared to the advantages they secure.

IV. (*g*) FLOOD WARNINGS

12. In modern systems of flood control, warnings are given to the people in advance by means of telephones, radios and telegrams. Radio sets will be found very useful during floods as even telegraph or telephone communications are liable to fail during heavy storms.

IV. (*h*) AERIAL CLOUD STREAMS

13. In the *Scientific American* of October 1938, a remarkable phenomenon was alluded to in an article by one Mr. Alexander Maxwell. It would appear that, just as is the case with ocean currents, there are aerial currents which appear like meandering clouds. These air currents instead of evenly distributing rain-

fall get concentrated in some restricted area or other, causing very high floods there. These aerial streams, it would appear, "snake and twist" like giant firehoses and change their course from one ocean to the other, say from the Atlantic to the Pacific. There is, however, one factor of safety as unlike earthquakes or tornedoes which come without notice, these streams appear, it is said, several days in advance of their discharging the burden and it is, therefore, possible to predict the appearance of a phenomenal flood. Though at a short notice of a week or a few days it may not be possible to devise effective protection works, it would be easy for the people to get out of the way of a flood in advance and save themselves and their property.

V. Financial Responsibility and Advisory Board of River Control

14. The works of flood protection are to be permanent ones, benefiting the future as well as the present generation. There must be, therefore, no undue burden thrown on a single generation. The works should be spread over many years and, as actual experience is gained from time to time, the nature of remedies should be developed by stages. The cost of protection works has no doubt to bear a certain proportion to the value of ascertained damages to be averted. When the local population is likely to derive benefit from the betterment of their property they will have to bear some part of the expenditure incurred.

In America the Federal Government has been financing protection works on big rivers like the Mississipi traversing many States. Individual States will not be able to finance costly works and it is but right that the Central Government should bear the burden.

The case is even stronger in India, where the Provincial finances are generally too slender to meet such liabilities. The Central Government should come to the aid of the local Governments even in cases where only one Province is involved as in the case of the Mahanadi delta in Orissa, and more so when more than one Province is concerned.

It would be indeed desirable, considering the huge interests involved, that the Government of India form an Advisory *Board of River Control* for the whole of India to examine all major schemes of flood protection and advise them as to the extent of financial help that may be rendered in each case.

VI. Conclusion

15. I have endeavoured to give in the foregoing pages an outline of the causes of destructive river floods and the remedial measures generally adopted for protecting life and property. It is not possible in the course of a paper of this kind to deal exhaustively with the various methods. Each area to be protected will have its own peculiarities and remedies will have to be adjusted to local causes and conditions. There can be no uniformity of method applicable to every case. Patient study and research extending over many decades will be needed for protecting large extents like the deltas of big rivers in India.

A careful examination of the flood problems will reveal that every kind of remedy has its place somewhere. "It is by a knowledge of the fundamental principles and ingenuity in their application that flood problems could be solved with assurance that the works would be economical and effective."

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PROPOSAL FOR WORLD UNIVERSITY

A Proposal for an International University from which lectures could be broadcast to students in their homes all over the world is to be discussed at the United Nations Education Conference in London. The idea has been sponsored by Professor Mikolaj Olekiewicz, teacher of Mathematical Statistics at the newly founded University of Lublin and one of the Polish delegates to the Conference.

Professor Olekiewicz, a fugitive from Germany during the occupation, believes that an International University would provide a practical answer to many problems in Europe where text-books had been burnt, schools destroyed and teachers killed. But he would at the same time like to see the University made permanent.

He adds: "My concept of the Faculty is this—prominent men of science, art and letters will be appointed from all countries of the United Nations. These men could deliver their lectures in their own studies merely by hooking up to the University's network. There would be no resident students. Young men and women all over the world could listen in their homes and at the same time enrol in correspondence courses conducted by the University. Once or twice yearly, students of the University should be given an opportunity of meeting other students—it would be fairly easy to arrange that."

BAT RADAR

BY JOHN ERIC HILL

(Drawing by G. Frederick Mason)

IN the post-war world, pilots of commercial airplanes will have radio instruments that will determine accurately the position of obstacles and their distances from the plane, as well as the altitude of flight and the physical conformation of the surface of the earth below. These radio detection devices, or radar instruments, function as well in fog and bad weather as they do in clear weather.

The public has been given enough information on radar to understand the general principles involved: Radio impulses are beamed out into space, and when any solid object is encountered, an "echo" rebounds. This echo is received by a detector which indicates the direction from which it comes and the time required for its return. . Since radio impulses travel with the speed of light, approximately

327 yards per microsecond (a millionth of a second), it is possible to compute accurately the distance the beam has travelled, half of which is the distance of the object.

Bats, the only mammals that can truly fly, use a similar method for avoiding obstacles in their darting flight. Instead of radio impulses, they emit a series of intense cries, pitched too high to be heard by the human ear, and they are guided by the echoes that their sensitive ears are tuned to hear. For generations, the ability of bats to make their way through the inky darkness of winding caves puzzled naturalists. More than 150 years ago an Italian scientist blinded bats and found they could fly as skillfully as ever. While their sight is far keener than usually believed ("blind as a bat" is one of our false proverbial sayings), these experiments proved that they did not depend on their eyes. Some years later an investigator found that if the ears were plugged, the flying skill of a bat was greatly impaired. This discovery was forgotten for many years, and naturalists almost without exception accepted an untried theory that special senses in the skin of the wings were responsible for the ability of bats to fly without hitting things.

In recent years,* however, bats and their flight were studied anew. A number of experiments showed that they had extremely keen hearing, especially for high-pitched sounds. With sensitive recording devices it was discovered that bats give forth a series of strong sounds, pitched far above the limit of our hearing—45,000 to 50,000 vibrations per second, as compared with our limit of about 20,000.

A soundproof room was divided by a hanging screen of metal wires, set about a foot apart. Bats were temporarily blinded and then made to fly through the wire barrier. Blind bats were as successful as normal bats in this test, confirming the old experiments. But when the bats were gagged so they could not make their sound, or when their ears were plugged so they could not hear it, they had great difficulties. They would not fly without much urging, and when they were forced to fly they went slowly, as if uncertain of themselves, bumping into the wires and even the walls again and again, unable to adjust to the unusual situation.

Blind persons make a similar use of echoes to avoid obstacles. The tapping of a blind man's cane along the sidewalk and the resulting echoes have been widely used for generations as a guide when sight could no longer serve. Studies of the problems of "echo-location" as this method has been called, are now in progress, and improvements in technique may be expected which will add greatly to the well-being of sightless persons.

—(*Courtesy of Journal of the American Museum of Natural History*, 1945, p. 315.)

*Griffin and Galambos, *Journ. Exper. Zool.*, LXXXVI (1941), 481-506; *Sci. Monthly*, LVI (1943), 155-162.

THE NOBEL PRIZE AWARDS

PROFESSOR W. PAULI (Switzerland), Princeton University, has been awarded the Nobel Prize for Physics for 1944.

The 1944 prize for Chemistry has been won by PROFESSOR OTTO-HAHN (Germany). The 1945 prize goes to PROFESSOR ARTURI VIRTMEN (Finland).

The 1945 prize for Medicine has been awarded jointly to SIR ALEXANDER FLEMING, SIR HOWARD FLOREY and DR. E. B. CHAIN for their contributions to penicillin.

The International Red Cross, Geneva, receives the Peace Prize for 1944 while MR. CORDELL HULL wins the Peace Prize for 1945.

LETTERS TO THE EDITOR

TESTS OF SIGNIFICANCE BY ANALYSIS OF COVARIANCE IN MULTIVARIATE POPULATIONS

The statistical significance of two multivariate samples can be judged by any one of the three methods mentioned below:—

1. Hotelling's T^2.
2. Discriminant function.
3. D^2-Statistic.

Prof. Fisher[1] after indicating the relations between these three tests has extended them to the examination of collinearity and coplanarity of samples and to testing the significance of the deviations in directions. Following Prof. Fisher, Roy[2] has obtained the distribution of the p-statistics for any number of samples. In this note I propose to show the relation between the T^2-test and the analysis of covariance.

Taking first the case of two samples it is known that

$$1+\frac{T^2}{N-1}=\frac{|e_{ij}|}{|e_{ij}|},$$

where $|a_{ij}|$ and $|e_{ij}|$ are the generalized variance within the samples and the two samples together. Using Yule and Kendall's[3] notation it has been shown (Krishna Iyer[4]) that

$$\frac{|a_{ij}|}{|e_{ij}|}=\frac{S^2_1\, S^2_{2\cdot 1} \cdots S^2_{n\cdot 12\cdots n-1}}{S'^2_1\, S'^2_{2\cdot 1} \cdots S'^2_{n\cdot 12\cdots n-1}},$$

where S^2 and S'^2 are the residual variances on the basis of size of samples within and the two samples together after fitting the regression equations. The degrees of freedom for $S^2_{r\cdot 12\cdots r-1}$ and $S'^2_{r\cdot 1\cdots r-1}$ and n_1+n_2-r-1 and n_1+n_2-r respectively; n_1 and n_2 being the sizes of the samples.

If there are more than two samples, then also

$$\frac{|a_{ij}|}{|e_{ij}|}=\frac{S^2\; S^2_{2\cdot 1} \cdots S^2_{n\cdot 12\cdot n-1}}{S'^2_1\; S'^2_{2\cdot 1} \cdots S'^2_{n\, 12\cdot n-1}}=W.$$

But the distribution of $\frac{|a_{ij}|}{|e_{ij}|}$ is very complicated when the number of samples is more than three. For three samples the distribution is given by

$$\frac{\Gamma\frac{N-1}{2}\;\Gamma\frac{N-2}{2}}{\Gamma\frac{N-n-1}{2}\;\Gamma\frac{N-n-2}{2}\cdot\Gamma n}\, W^{\frac{N-n-4}{2}}\,(1-W)^{n-1}\; F\left[\frac{n-1}{2},\frac{n}{2}, n, (1-W)\right],$$

where F as usual denotes a hypergeometric series; N and n are the size of the three samples together, and the number of variates involved in the samples. For more than three samples also the distribution can be obtained by using the methods given by Wilks.[5] But the expressions are very complicated and hence probably it would be easier to test the significance by taking the ratios $S^2_{r\cdot 2\cdots r-1}/S'^2_{r\cdot 12\cdots r-1}$ for different values of r.

Imperial Agricultural Research Institute, New Delhi,
P. V. Krishna Iyer.
July 3, 1945.

1. Fisher, R. A., "The statistical utilization of multiple measurements", *Ann. Eug.*, 1938, **8**, 376-386. 2. Roy, S. N., "Analysis of variance for multivariate normal populations. The sampling distribution of the requisite p-statistics on the null and non-null hypothesis,' *Sankhya*, 1942, **6**, 35-50. 3. Yule, U. G., and Kendall, M. G., *An Introduction to the Theory of Statistics*, G. Griffin & Co., Ltd., London, 1940, 259-284. 4. Krishna Iyer, P. V., "A note on Hotelling's T^2,' *Curr. Sci.* 1945, **14** 173-175. Wilks, S. S., 'Certain generalizations in the analysis of variance," *Biom.*, 1932, **24**, 471-94.

RADIATIVE EQUILIBRIUM OF THE ATMOSPHERE AND THE THERMAL STRUCTURE OF THE TROPOSPHERE

THE earth and its atmosphere constitute a system which is continually absorbing short-wave solar radiation and re-radiating it back into space in the form of long-wave heat radiation. The theory of radiative equilibrium demands that on the average and considered over a long interval of time, the total amount of solar radiation absorbed by the system should be exactly balanced by the total amount cutgoing terrestrial rediation. Because of the fact that the atmosphere is largely transparent to the incoming solar radiation (barring the absorption in the ultra-violet due to ozone whose centre of gravity is probably above 20 gkms.), most of the short-wave radiation is absorbed either at the surface of the earth or in the layers of the atmosphere close to the surface. On the other hand, except in certain narrow spectral bands where they are either partially or completely transparent, the water vapour and carbon dioxide present in the atmosphere are highly opaque to wave-lengths in the range of terrestrial radiation. As a consequence, most of the heat radiation sent out from the earth is absorbed by the water vapour and carbon dioxide in the first few metres of the atmosphere. Atmospheric water vapour and carbon dioxide in their turn re-radiate energy in the same range of wave-lengths over which they absorb. But the radiation from any layer of the atmosphere is absorbed in the layers above and below it, and this process of radiation and absorption goes on from layer to layer until we reach a level in the atmosphere above which the amount of water vapour and carbon dioxide is insufficient to absorb completely all the radiation coming from below. Radiation into outer space commences from such a level.

From his study of the emission and absorption by water vapour in the atmosphere, F. Albrecht[1] arrived at a result of fundamental importance regarding the flux of long-wave heat radiation in the atmosphere. He found that practically the entire energy lost to space from the atmosphere originates from a layer of some 3 to 4 kms. thickness in the upper troposphere which he designated as the *Emission Layer*. The height and thickness of Albrecht's emission layer depends upon the water vapour content of the atmosphere. According to Albrecht's estimates the emission layer should lie approximately between $-40°$ C. to $-60°$ C. in the humid tropical atmosphere and between $-30°$ C. to $-50°$ C. in the atmosphere over polar and temperate latitudes where the moisture content is less. The top of the emission layer coincides with the tropopause in polar and temperate latitudes while on account of the violent penetrative convection the tropopause is carried a few kilometres above the top of the emission layer in the tropics.

Taking into consideration convective and radiative processes in the atmosphere, Bjerknes and collaborators[2] have given diagrammatically a meridional section of the atmosphere shownig the probable vertical distribution of the zones of gain and loss of heat energy. This diagram shows a striking difference in the vertical distribution of heat and cold sources in summer and in winter over a place at about the latitude of Agra (lat. 27° 08′) and suggests that the thermal structure of the atmosphere over such a place in summer and in winter should be very different.

From an analysis of the records of over 500 sounding balloons let off from Agra during the period 1929-38, I have found that a number of features relating to the thermal structure of the atmosphere over this place can be explained on the basis of the existence of Albrecht's emission layer in the upper troposphere and the seasonal variation of its altitude. The more important of these features are:—

(1) Occurrence of super-adiabatic lapse-rates between 11 and 15 gkms. over Agra in the monsoon months.

(2) Occurrence of comparatively high lapse-rates between 7 and 11 gkms. in the winter months.

(3) Sudden decrease in the lapse-rates above 10 or 11 gkms. in the winter months (*vide* Fig. 1).

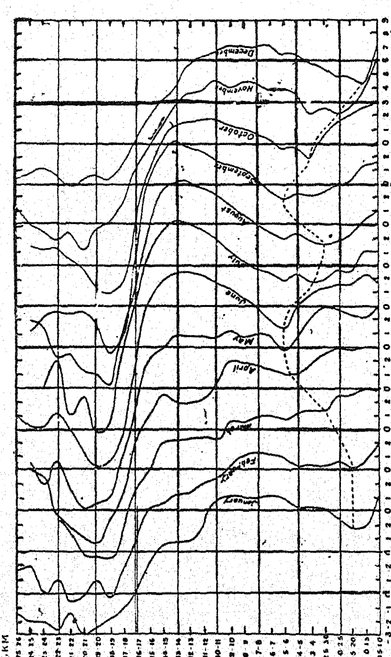
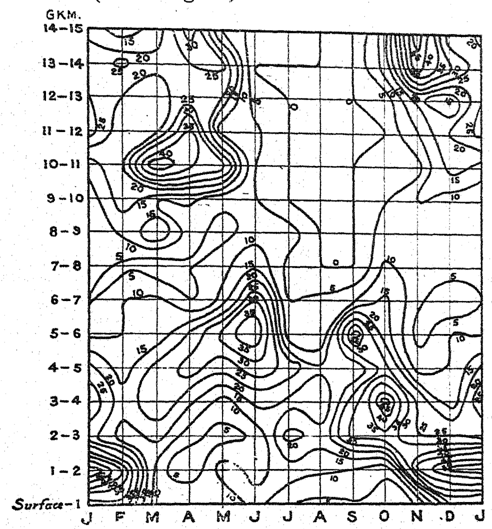


FIG. 1

(4) Composite type of tropopause encountered over Agra in the non-monsoon months.

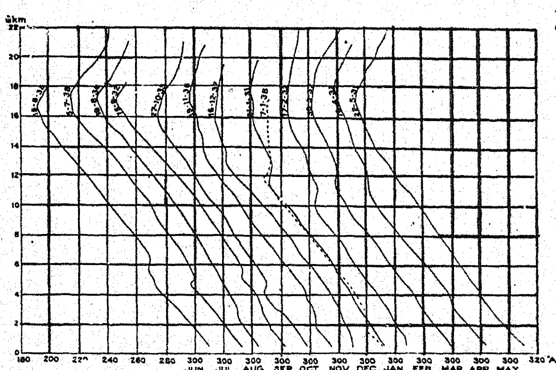
(5) Large frequency of occurrence of inversions and isothermal layers above 10 gkms. in the non-monsoon months (*vide* Fig. 2).



Isopleths of percentage frequency of inversions and isothermals over Agra.

FIG. 2

(6) Very pronounced inversion at the tropopause in the monsoon months but less pronounced inversion at that level, in the non-monsoon months (*vide* Fig. 3).

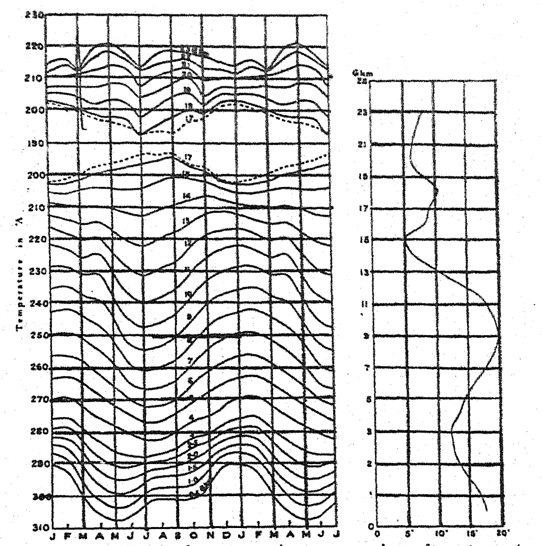


Some typical height-temperature diagrams over Agra

FIG. 3

(7) Occurrence of a very pronounced maximum in the annual range of temperature over Agra at 9 gkms. and of a less pronounced maximum at 18 gkms. (*vide* Fig. 4)

A detailed paper on the subject is being published as a *Memoir of the India Meteorological Department*. The investigation was completed in April 1942, but the paper could



Annual variation of temperature over Agra ...ual range of temperature over Agra.

FIG. 4

not be published on account of war-time restrictions.

Meteorological Office,
Upper Air Section,
Poona 5, R. ANANTHAKRISHNAN.
October 29, 1945.

1. Albrecht, F., *Zeit. f. Geophysik*, 1930, **6**, 420. —, *Met. Zeit.*, 1931, **48**, 57. 2. Bjerknes, V., Bjerknes, J., Solberg, H., and Bergeron, T., *Physikalische Hydrodynamik*, 1933, 665–67.

TAMARIND SEED PECTIN

IN a previous publication[1] it was reported that when an aqueous extract of tamarind kernel is treated with twice its volume of alcohol, a voluminous fibrous precipitate is obtained and that it forms a well-set jelly in acid medium, when mixed with an appropriate amount of sugar. On account of this characteristic property the substance was designated as pectin. The material as obtained by this method usually contains 14 per cent. of proteinous matter, some carbohydrates, and a little combined phosphorus, and the removal of these associated substances, especially the proteins, is often difficult and tedious. It has now been noticed that if, instead of using the seed flour as the starting material, pounded seeds (size of a sweet pea) are taken for extraction, most of the proteins and fibres remain with the swollen seeds and the pectinous matter passes into solution, giving a purer material. By dissolving in water to form a thin solution, centrifuging and subsequently precipitating with alcohol, the pectinous substance containing below 1·5 per cent. of protein is easily obtained. Further lowering of the protein content is possible by repeating the operations a few times. Final purification may also be effected by preparing

either the copper or the barium compounds and regenerating the substance.

The aqueous solution of the pure material is dextrorotatory and does not reduce Fehling solution. It has a very low acid number.[2] In its colour reaction with iodine the substance differs considerably from starch. When only a few drops of iodine are added to 0·5 per cent. solution, a bright yellow colour is formed; but with excess a greenish blue colour is produced. The latter colour, however, changes to yellow almost at once, if diluted with water. The substance yields metallic compounds with cupric ammonium sulphate, Fehling solution, barium hydroxide and basic lead acetate, which separate out from water as flocculent precipitates. Purified through any of the salts by treatment with appropriate acid, it retains in full the jelly-forming properties. On addition of borax its aqueous solution is readily converted into a thick gel.

Nanji *et al.*[2] have shown that tamarind seed pectin differs from fruit pectins in properties and composition. Our experiments also lead to similar results. Unlike fruit pectin it does not contain any uronic acid nucleus or methyl ester grouping. Our further experiments show that on hydrolyses with 5% sulphuric acid it yields xylose, galactose and glucose and on oxidation with nitric acid, mucic and saccharic acids as the primary products. But we have not been able to get *l*-arabinose amongst the products of hydrolysis or repeat the other data reported by Damodaran and Rangachari.[3]

Tamarind seed pectin seems to resemble seed-pectins more than fruit-pectins. The seed pectin, for example, from coffee, does not contain any uronic acid nucleus but on the other hand is reported to yield galactose and pentose on acid hydrolysis and mucic acid on oxidation with nitric acid.[4] Experiments aiming at the elucidation of the constitution of tamarind seed pectin are in progress, and the details will be published elsewhere.

T. P. Ghose.
S. Krishna.

Chemical Laboratories,
Forest Research Institute,
Dehra Dun,
August 1, 1945.

1. Ghose and Krishna, *J.I.C.S.*, *Ind. & News Ed.*, 1942, **5**, 114. 2. Nanji *et al.*, *Curr. Sci.*, 1945, **14**, 129. 3. Damodaran and Rangachari, *Curr. Sci.*, 1945, **149**, 203. 4. Gorter, *Ann.*, 1908 **359**, 235.

A NEW METHOD FOR MEASURING THE TIME OF SETTING OF GEL-FORMING SYSTEMS

Several methods have been suggested for the measurement of the time of setting of gel-forming systems which is the main property characterising a gel. The setting condition has been variously defined such as the approach of a certain value of viscosity or the attainment of a constant value of some optical property. The viscosity methods employ certain criteria involving a number of arbitrary experimental conditions. For instance, Fleming's method[1] requires that the container must be filled up to a particular volume; Hurd and Letteron's method[2] requires that a particular length of rod of a specific diameter should be dipped at a particular angle in the gel-forming solution; if Fells and Firth's method[3] is employed, it is necessary that the air bubbles should be blown at a particular rate or pressure. If these conditions are changed, different values of the time of setting are obtained. Further, in the methods involving viscosity considerations, the gel-forming system as a whole has to be disturbed several times during measurement, this disturbance being the least in the case of Hurd and Letteron's method. Methods involving the actual measurement of viscosity should give values far from truth because these measurements, by any method, involve continual disturbance of the gel-forming system. This disturbing factor is wholly eliminated if optical properties are employed, but it has been shown that methods depending upon these properties are inapplicable in the case of systems which are either optically void or highly opaque. The authors have devised a method in which the least disturbance is given to the gel-forming system and no arbitrary conditions are prescribed.

When a body is made to vibrate up and down in a liquid, ripples are produced which spread outward along the surface of the liquid, and become feebler, through attenuation, as the circles become larger, and their amplitude is reduced as they progress. The logarithmic decrement of these ripples depends upon the resistance offered by the liquid, the damping effect. In the case of a gel-forming system, the resistance is predominantly offered by the viscosity of the system which increases during setting. This will increase the logarithmic decrement, and will, therefore, decrease the distance travelled by the ripples. The propagation of the ripples will stop when the viscosity becomes very high. Hence, if ripples are produced in a gel-forming system, they will be propagated quite freely in the beginning; in course of time, the distance travelled by them will decrease and after a certain time no ripples will be propagated. This condition would, therefore, indicate that the gel has set.

The actual experimental conditions were realised by means of a ripple projector provided with a stroboscopic arrangement. The gel-forming solution was contained in a watch-glass, and the height of the vibrating fork was so adjusted that the gel-forming system as a whole was not disturbed. It was observed that initially the ripples spread over a large area, but their size diminished as the setting point is approached and the propagation stopped completely when the gel had set. The time taken by the gel-forming system to reach this condition has been taken as the time of setting. The diminution in the extent of the area to which the ripples spread can be seen from the disappearance of the ripples from the far end, and by noting the successive disappearances of the several ripples it is possible to surmise the velocity of gelation of the system.

The values of the time of setting obtained by this method, with both inorganic and organic gels, are correct within 2 to 3 per cent. and are independent of the frequency of the vibrating fork and the size and shape of the vessel containing the gel-forming system. The disturbance imparted to the setting gel is minimum; this makes the present method more accurate and superior to the other methods used so far. A detailed account of this work will be published elsewhere.

The authors are grateful to Professor Mata Prasad, D.SC., F.R.I.C., for his keen interest during the progress of this work. Thanks are also due to the authorities of the University of Bombay for the award of a Research Scholarship to one of the authors (G.S.H.).

G. S. HATTIANGDI.
S. S. DHARMATTI.

Chemical Laboratories,
Royal Institute of Science,
Bombay,
October 8, 1945.

1. Flemming, *Zeit. Physik.*, 1902, **41**, 427. 2. Hurd and Letteron, *J. Phys. Chem.*, 1932, **36**, 606. 3. Fells and Firth, *Trans. Farad. Soc.*, 1927, **23**, 623.

CATALYTIC DEHYDROGENATION OF BUTENE TO BUTADIENE

IN the course of our investigation on the catalytic dehydrogenation of butene to butadiene in the presence of carbon-dioxide, a specially prepared ironoxide-chromia-alumina catalyst exhibited remarkable activity. Contrary to the usual belief that iron or its oxides are unsuitable as dehydrogenation catalysts in the case of olefins, we have found that a catalyst of the type Fe_3O_4-Cr_2O_3-Al_2O_3 can promote simultaneously dehydrogenation and water-gas reactions in butene-CO_2 system, resulting in very high yields of butadiene:

$$[CH_3-CH=CH-CH_3 \rightleftharpoons CH_2=CH-CH=CH_2+H_2] \quad (1)$$

$$CO_2+H_2 \rightleftharpoons CO+H_2O \quad (2)$$

The presence of excess of CO_2 in the system is necessary to prevent formation of free iron in the catalyst as this would cause considerable fission of the C-C bonds. The catalyst was prepared by co-precipitating the hydroxides of iron, chromium and aluminium from a mixed solution of their nitrates. The hydroxide gel was dried and reduced in a current of hydrogen at 550-600° C. for 8 hours. The free iron in the catalyst was then oxidised preferentially to magnetic oxide by CO_2 at 500° C. according to $3\,Fe+4\,CO_2 \overset{<550°C}{\rightleftharpoons} Fe_3O_4+CO_2$. The best catalyst was found to be the one containing 15 per cent. Fe_3O_4, 80 per cent. Cr_2O_3 and 5 per cent. Al_2O_3. The results of careful experiments in a flow system showed that at 600° C. and in the absence of CO_2 the catalyst causes 12-14 per cent. dissociation of butene to butadiene. When CO_2 was used with butene in the ratio of 2:1, interesting results were obtained. At the temperature of about 580° C., the formation of butadiene was maximum, being 38 per cent. on the unsaturates per pass which, however, slowly fell with time to a constant conversion rate of 30-32 per cent. The degree of fission was as low as 5-10 per cent. on the butene passed. At temperatures below 580° C., the rate of dehydrogenation was slow while above that temperature the yield of butadiene remained practically stationary. Data for a few typical experiments are given in the accompanying table.

The efficiency of the iron catalyst will be evident on comparing the above data with Balandin's,[1] whose best results involve use of butene to CO_2 in the ratio of 1:7. In the temperature range of 570-600° C. he obtained yields of 27-34 per cent. butadiene (fission 20-25 per cent.) on butene passed and the concentration of butadiene was not greater than 4 per cent. in the contact gas. Working at the reduced pressure of 180 mm., Grosse and co-workers[2] could obtain about 22 per cent. yield of butadiene with 20 per cent fission.

In order to elucidate the mechanism operative on Fe_3O_4-Cr_2O_3-Al_2O_3 catalyst, quantitative measurements of the reaction were made. It was found that hydrogen was practically absent in the reacted gases and carbon monoxide was formed in large quantities. Also no liquid products were formed with this catalyst. The former is explained by the fact that iron oxide, which is known to be a good catalyst for water-gas reaction,[3] is responsible for the formation of CO and removal of free hydrogen which is formed through dissociation of butene:

$$CO_2+H_2 \rightleftharpoons CO+H_2O \quad (2)$$

$$Fe_3O_4+H_2 \rightleftharpoons 3FeO+H_2O \quad (3)$$

No.	Temp. °C.	Space velocity	Ratio of butene to CO_2	Analysis of the gases collected, in% CO_2	CO	Unsatd. hydrocarbons	Satd. hydro carbons and residue	Yield of Diene %	Fission %	Concn. of butadiene in contact gas. in %
1	555	550	1:2	57	3·5	33·0	6·5	18·0	6·0	6·0
2	575	,,	,,	57	2·1	34·0	6·9	25·0	4·0	8·5
3	585	557	,,	55	6·2	25·2	13·6	38·9	10·0	9·8
4	580	550	,,	51·5	9·5	22·5	16·5	34·2	7·8	7·7
5	585	,,	,,	61·4	4·2	30·3	4·1	30·6	8·0	9·3
9	600	,,	,,	52·9	13·7	21·3	12·1	29·0	11·0	6·2

The activity of the catalyst, however, does not change, once a steady state is reached, due to the regeneration of Fe_3O_4 *in situ* by CO_2

$$3\ FeO + CO_2 \rightleftharpoons Fe_3O_4 + CO \quad \ldots\ldots \quad (4).$$

Carbon dioxide also helps to remove free carbon which might have been formed though fission on the surface of the catalyst: $C + CO_2 \rightleftharpoons 2\ CO$, thus maintaining the activity of the catalyst steady for long periods. In order to verify that iron initiates the above reaction mechanism only when associated with $Cr_2O_3 - Al_2O_3$ in the form of its magnetic oxide, a catalyst composed of iron chromite (prepared by a method similar to Adkin's[4] method) and alumina was made and studied under conditions exactly similar to those given above. Under best conditions, it was found that this catalyst causes only 16-18 per cent. dissociation of butene to butadiene.

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C. D. Srinivasan.
A. N. Roy.

General Chemistry Section,
Dept. of Pure & Applied Chemistry,
Indian Institute of Science,
Bangalore,
November 13, 1945.

1. Balandin, A. A., *Acta Physico Chemica*, 1943, **18**, 68–90. 2. Grosse, A. V., Morrell, J. C., and Mavity, J. M., *Ind. Eng. Chem.*, 1940 **32**, 309–11. 3. Pease and Taylor, *J. Phys. Chem.*, 1920, **24**, 255. 4 Adkins and Connor, *J. Amer. Chem. Soc.*, 1931, **53**, 1091.

BIOLOGICAL ASSAY OF THE OVERALL POTENCY OF THE GROWTH FACTORS ASSOCIATED WITH YEAST AUTOLYSATES AND LIVER EXTRACTS

The suitability of *Corcyra cephalonica* Staint. (rice moth) larvæ for the assay of some of the vitamins of B-complex has already been demonstrated. We have now explored the possibility of assaying the overall growth-promoting potency of yeast autolysates and liver extracts employing these larvæ as test animals.

A synthetic basal diet consisting of vitamin-free starch (B.H.D.), casein (B.H.D.), sucrose treated with "norit" and recrystallised and salt mixture was used. A composition of the salt mixture was as follows:—

Calcium lactate 35·15 g., $Ca(H_2PO_4)2\ H_2O$ 14·60 g., K_2HPO_4 25·78 g., $Na_2HPO_4\ H_2O$ 9·38 g., NaCl 4·67 g., $MgSO_4$ 7·19 g., Iron citrate 3·19 g.

The basal diet was compounded as follows:—

Starch 18·0 g., Casein 1·0 g., Sucrose 1·0 g., Salt mixture 0·5 g.

One ml. of a 1:1 mixture of cod-liver and refined groundnut oil served to supply the necessary fat-soluble growth factors.

Experimental Details

A. *Yeast autolysate* was prepared by autodigesting 10 g. of air-dry yeast (S. cervisæ) with 40 ml. toluene-saturated water at 40° C. for 18 hours. On centrifuging the suspension, the extract was decanted and made up to 40 ml. with water; this extract was found to contain 9·73 per cent. of total solids. Experimental diets fortified with 1 ml. and 2 ml. of the yeast autolysate were prepared.

Newly hatched rice moth larvæ were fed for the first ten days on whole jowar and thereafter maintained on starch-casein-basal diet from which the oil had been excluded. Finally they were transferred to the experimental diets. Whole jowar and the basal diet, with and without the oil were used as controls.

B. (1) *Liver extract* (Cohn's faction G.) obtained from the Industrial Testing Laboratory, Bangalore, was dissolved in water so as to give a solution with a total solid content of 9·73 g. per cent.

Experimental diets each containing 1 ml., 3 ml. and 5 ml. of the liver extract were prepared.

(2) *Autoclaved liver extract.*—Further experiments were carried out with liver extract, autoclaved at 30 lbs. for 4 hours. Diets were prepared each containing 1 ml. and 3 ml. of the autoclaved liver extract. Feeding experiments with a diet containing 3 ml. of the unautoclaved liver extract together with an adequate control, were also carried out. Results are given in Tables II and III.

Table I

Diet	Average wt. of 10 larvæ in mgm. after						
	0 days	7 days	14 days	21 days	28 days	35 days	
I. Basal diet without oil	3·09	4·69	5·33	5·75	one survived	one survived	No pupæ
II. Basal diet with oil	3·17	6·67	7·60	7·57	7·24	10·75	..
III. Basal diet II + 1 ml. yeast autolysate	2·98	5·28	12·21	29·83	51·05	53·45	2 pupæ
IV. Basal diet II + 2 ml. yeast autolysate	3·31	8·83	33·92	75·38	117·34	Most pupated	Most pupated
V. Whole jowar	3·29	31·17	94·86	99·70	All pupated	All pupated	All pupated.

TABLE II

Diet	Average weight of 10 larvæ in mgm. after.					Remarks
	0 day	14 days	21 days	28 days	35 days	
I. Basal diet (*a*)	16·32	16·64	5·98	8·34	10·58	No pupæ.
Without oil (*b*)	17·50	11·58	20·50	16·18	15·16	..
II. Basal diet (*a*)	16·30	23·26	22·60	18·96	15·18	..
+ oil (*b*)	16·06	15·28	16·82	14·26	14·48	..
III. Basal diet II (*a*)	15·02	48·40	53·62	58·46	67·46	..
+1 c.c. Liver extract (*b*)	16·58	34·22	25·94	30·84	47·34	..
IV. Basal diet II (*a*)	14·66	50·16	..	..	..	..
+3 c.c. Liver extract. (*b*)	16·38	61·18	52·36	56·64	59·90	..
V. Basal diet II (*a*)	14·00	46·16	61·22	82·34	..	1 pupæ.
+5 c.c. Liver extract (*b*)	15·26	46·18	..	..	..	..

TABLE III

Diet	Average wt. of 10 larvæ in mgm. after			
	0 day	14 days	25 days	35 days
(*a*) Basal diet II + 3 c.c. autoclaved Liver extract	6·04	14·24	16·60	13·74
(*b*) Basal diet II + 3 c.c. unautoclaved Liver extract	5·85	11·05	36·80	72·84

It will be seen from the tables that the insect responds definitely to the fortification of its basal diet with yeast autolysates and liver extracts and a roughly quantitative relationship may be perceived to exist between growth and the degree of enrichment. Both from the point of view of the rate of growth and of percentage of pupation, yeast autolysate gives a result which is far more satisfactory than that obtained with liver extract. It is revealed that autoclaving at 30 lbs. for 4 hours appears to destroy the growth-promoting factors associated with the liver extract.

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STABILITY OF VITAMIN C IN DRUMSTICK LEAF

THE leaf of the drumstick tree (*Moringa oleifera*) has long been known to be a rich source of ascorbic acid,[1,2] providing 900 to 1,100 mgs. per cent. of this vitamin. The edible portion of the pod also contains nearly one per cent. of the vitamin and, being free from interfering substances, was at one time suggested as a suitable standard for titrating indo-phenol indicator solutions.[1] The leaf, however, contains, in addition, 100 to 110 mgms. per cent. of β-carotene[2,3] as determined spectrophotometrically after phase separation and chromatographic adsorption over Brockman's alumina[4] and is, therefore, richer in this respect than either lucerne[5] or rose hip,[6] two of the natural sources of ascorbic acid and carotene which have been successfully processed[7,8] to yield rich concentrates.

In the course of investigations on the processing of drumstick leaf by fractionation and dehydration methods so as to obtain rich concentrates of ascorbic acid and carotene, interesting results were obtained in regard to the relative stability, under ordinary conditions of exposure, of ascorbic acid in aqueous extracts when examined during pre-flowering (October-November) and flowering stages (January-February). Some typical data are reported in Table I where the results for lucerne leaf sampled during the two periods and for an aqueous solution of pure ascorbic acid are included for comparison.

TABLE I
Stability of ascorbic acid in plant sources

Source	Mgm. per cent. ascorbic acid in			
	HPO_3 (5 per cent. Extract)	Aqueous extract at the end of		
		0 hrs.	24 hrs.	72 hrs.
Drumstick leaf–pre-flowering stage	1,143	888	840	666
Drumstick leaf-flowering stage.	985	112	64	..
Drumstick flowers I	1,250	50	..	..
Drumstick flowers II	1,665	66	..	..
Lucerne leaf sampled in October	960	841	328	294
Lucerne leaf sampled in February	920	800	278	237
Ascorbic acid (pure)	25	21	9	..

These results show that a water extract of drumstick leaf is remarkably stable when

sampled during the period of maximum vegetative growth, there being only 25 per cent. loss in ascorbic acid even after three days' storage. On the other hand, a powerful oxidase system is apparently developed in the leaf when the tree is in flower, more than 80 per cent. of the vitamin being lost during extraction alone. This oxidase activity is even more with the flowers where practically the whole of the ascorbic acid is destroyed instantaneously in the aqueous extract.

Whether the destruction of the ascorbic acid during extraction with water and subsequent storage has been due to the specific oxidase elaborated during flowering has not been fully investigated. But, in experiments with aqueous ascorbic acid, addition of a heated water extract of the leaf sampled at flowering stage resulted in a destruction, during 24 hours, of only 44 per cent. of the original vitamin C content as against 74 per cent. with a corresponding quantity of unheated water extract. These results as also a comparison of the relative stabilities of water extracts of the leaf and of aqueous ascorbic acid would suggest that, in addition to the oxidative heat-labile enzyme, plants contain a thermostable protective factor as postulated by Krishnamurthy and Giri.[10] It cannot, however, be stated on the basis of existing knowledge that the activities of the oxidase and of the protective factor could vary independently in different plants and during different seasons.

The foregoing observations on drumstick leaf have been amply confirmed from an examination of a large number of flowering trees. Besides, the non-existence of a powerful oxidase system was demonstrated during the same season in two instances where the trees were not in flowers due either to immaturity or to excessive defoliation.

In contrast with drumstick leaf, the results obtained with lucerne do not show any wide variation in oxidase activity during the two consecutive seasons; but, it must be borne in mind that this plant is grown largely for its fodder and that, therefore, cuttings are taken frequently, as was the case in the present instance, thereby preventing its reproductive phase. Presumably, this modifies the effect of season on the ascorbic acid-ascorbic oxidase system.

That seasonal variations in the concentrations of ascorbic oxidase and of dehydro-ascorbic acid reductase[11] may be considerable is shown by the results of Crook and Morgan[12] for cauliflower. The evidence recorded here would strongly suggest that these enzyme systems concerned in the reversible oxidation-reduction of ascorbic acid are of possible significance in the biosynthesis of this vitamin in plants. Support is lent to this view by the recent findings of Zilva, Kidd and West[13] that there is a decrease in the ratio of dehydro-ascorbic acid to ascorbic acid in the total vitamin C content of the apple as the fruit approaches maturity. No attempt has been made to follow up the dehydro-ascorbic acid and its reductase contents in drumstick leaf during the different developmental stages of the plant, but there is little doubt that such a study will eventually yield information of physiological importance.

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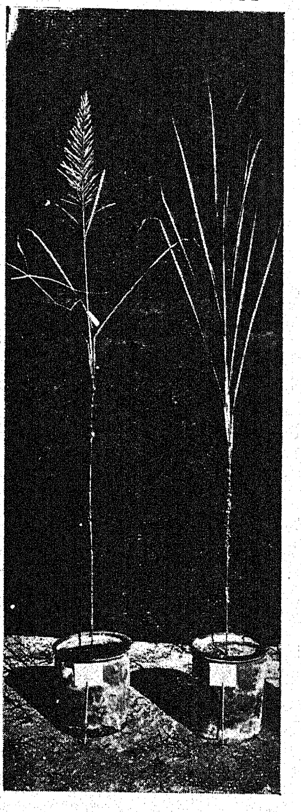
PHOTOPERIOD IN RELATION TO FLOWERING IN SUGARCANE

At a breeding station it often becomes necessary to control the flowering of varieties in order to effect certain crosses. In sugarcane the problem is not only of controlling the time of flowering but also of inducing certain varieties to flower as quite a number of them do not usually flower under the normal conditions. As is well known the 'day-length factor' greatly influences the transition from the vegetative to the reproductive phase. The study of 'day-length factor' has recently received increasing attention at the Imperial Sugarcane Breeding Station, Coimbatore. The earlier work at Coimbatore started in 1932 (Dutt, 1943) and was concerned mainly with the delaying and hastening of the flowering time in certain commercial cane varieties. Sartoris (1938) and also Allard (1939) studied the effect of different day-lengths on *Saccharum spontaneum* 28, NG 292 and observed that this variety produced rudiments of flowers only with 13 hours day—the full day of the locality of the experiment—and that slight alterations in the duration of the day inhibited flowering.

Recently the writers took up for study two of the forms of *S. spontaneum* which do not normally flower at Coimbatore. It was considered desirable to study the photoperiodic response in such varieties as many of them would be very useful breeding material if they could be induced to flower. The photoperiodic response of three cultivated varieties was also studied.

The variety *S. spontaneum* (Burma)—a tall vigorous variety which does not flower at Coimbatore, was induced to flower by subjecting it to long periods of darkness about eight weeks prior to the commencement of flowering season. This variety was planted in the field in December 1942 and was allowed to grow under the normal conditions for the first eight months. At this stage a number of top portions consisting of upper half of a primary stalk were removed from the field and planted upright in large-sized pots, one in each pot, containing the ordinary garden land soil. (Top portion represents the upper half of a



Treated Control

FIG. 1. Showing the effect of long periods of darkness on 8 months old tops of the non-flowering variety *S. spont.* Burma

primary stalk.) When the tops had resumed growth, *i.e.*, after about 20 days of planting, these were divided into different series, of 5 pots each, and one of these series was daily given only two hours of daylight from 12 noon to 2 p.m., and for the rest of the day it was kept in a dark-room. This treatment was continued for two months—from 10th September to 10th November—and then the plants were restored to normal day-length conditions. About three weeks after stopping the treatment all the tops began to show indications of flowering and at the end of December one of them arrowed (Fig. 1). The arrow was normal and healthy. The remaining stalks were dissected and examined and they revealed the presence of young developing flowers. The series subjected to other day-length treatments, namely, 10 hours, 14 hours, 22 hours and the normal daylight did not show any sign whatever of flowering.

The above experiment was repeated and confirmed during the year 1943-44; some arrows which were obtained were successfully utilized for crossing.

S. spontaneum (Assam 301) is another wild form which does not normally flower at Coimbatore. During the year 1942-43 it was grown in the field under different lengths of day to determine the photoperiodic conditions suitable for its flowering. The planting was done on 12th February 1943. Single rows of 20 plants were used for each of the following five-day length treatments—6, 9, 15, 18 hours and the full day. The treatments were commenced when the plants were one month old and were continued to the end of the experiment. The artificial light was obtained from 100 C.P. electric bulbs and extra darkness was provided by special light-proof enclosures erected in the field. This variety flowered with 9 hours day-length The first arrow emerged on 16th September, *i.e.*, 7 months after planting. Subsequently 18 more arrows emerged, all normal and healthy, the flowering continued to the middle of October. The other treatments including the normal day did not give any indication of flowering.

The times of flowering of certain cultivated cane varieties were delayed by seven to eight weeks by varying the length of day; this period of eight weeks practically covers the range of disparity in the times of flowering of late and early varieties at this station. Three varieties were studied, *viz.*, P.O.J. 2725, P.O.J. 2714 and Co. 421. These were planted in the field, in rows, on 6th December 1942. Five day-lengths were used, *viz.*, 6, 9, 15, 18 hours and the full day. The arrangements for controlling the day-length were made in the field, as described above. The treatments were commenced when the plants were three months old and were continued for another three months, *i.e.*, till the end of 6th month. The results obtained were as below:—

With the normal daylight conditions the variety P.O.J. 2725 flowered on 22nd September 1943 and the flowering continued till 15th October 1943. With 18 hours day-length flowering commenced on 21st October, *i.e.*, one month later, and continued till 8th November 1943. With 6 hours day-length flowering commenced on 19th October and continued till 29th December, *i.e.*, the arrows of this variety were available for crossing even two months after the control had finished off flowering. With other day-lengths, *i.e.*, 9 hours and 16 hours, the differences in the time of flowering were not so marked.

The variety P.O.J. 2714 flowered under the normal conditions on 10th October 1943 and it continued to flower till 27th October 1943. With 18 hours the flowering commenced on

15th November, *i.e.*, about 36 days later, and the arrows continued to emerge till 14th December, *i.e.*, 47 days after the control had finished off flowering. With other day-lengths the differences in the time of flowering were not so marked, except that with 6 hours day-length the flowering commenced 22 days later.

The variety Co. 421 flowered with 18 hours day-length one month later than the control and the flowering continued till 16th November whereas in the control plants it finished off on 23rd October.

It also seems worthy of mention that potted top portions (described above) of Co. 421, a pollen sterile variety, when supplied with 3 hours of extra light, *i.e.*, 15 hours day-length, about seven weeks before the flowering was due, *i.e.*, from 6th September to 20th October 1943, yielded 80 per cent. open anthers and healthy and well-developed pollen, which gave about 10 per cent. germination. The electric bulbs used in this experiment to supplement the daylight were of 500 C.P. The tops subjected to other day-length treatments, *viz.*, 24 hours and the full day did not yield any pollen.

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TWO NEW RECORDS AND A NEW SPECIES OF THE GENUS *TRICHURIS* FROM DOMESTIC RUMINANTS

Ostertagia pinnata and *Ostertagia gruhneri* are recorded from the material collected from Mukteswar in September 1942 while *Trichuris ovina*, a very common and widely distributed parasite was observed from various regions of the Punjab and United Provinces in different parts of the year.

Ostertagia pinnata Daubney (1933)

Daubney (1933) described the species from Kenya, its distribution being restricted to Romney Areas (Highlands) only. The present record is based on the presence of a single male specimen in a collection from Mukteswar. The individual possesses all the characteristics of the species, measures about 10 mm. long and has a width adjacent to the anterior ends of the spicules of about 0·14 mm. The spicules measure about 0·26 mm. each. Host—*Ovis aries*; Location—Abomasum; Locality—Mukteswar (Kumaon).

Ostertagia grühneri Skrjabin (1932)

The parasite was originally recorded from a reindeer in Russia. Dikmans (1939) records it from *Ovis canadensis*, *Ovibos moschatus* (musk ox), *Rangifer tearandus* (reindeer) from North America. The spicules of the specimen in this collection are dark yellowish brown in colour and measure about 0·16 mm. long each. Gubernaculum is absent. Host—*Bos indicus*; Location—Cæcum; Locality—Mukteswar (Kumaon).

Trichuris ovina sp. n.

Male: Length of anterior part is from 32-40 mm.; posterior part 17-20 mm.; breadth of posterior part about 0·5 mm. in the middle of the region of the ejaculatory duct and 0·64 mm. in that of the vas deferens. The body carries a papilla on either side of its posterior end.

The spicule is small and thin having a proximal thickening and ending with truncated edges (Fig. 1) followed by a hyaline part '*b*'. It measures from 1 to 1·5 mm. long and about 0·025 mm. broad.

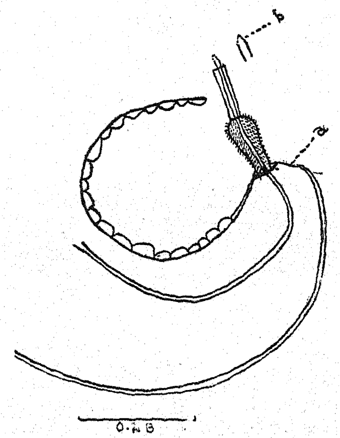

FIG. 1. *T. ovina*; posterior end of male

The sheath, wherever it is everted has a club-shaped appearance, having a length equal to that of the mouth-piece itself of about 0·14 mm. The sheath is studded all over with very fine and dense spines measuring about 0·0015 mm.

The testis starts in the cloacal region, with moderate convolutions in the region of ejaculatory duct, which are, however, closer and more restricted to one side in that of vas deferens. The vas deferens is from 3·9 to 5·2 mm. long; the ejaculatory duct from 11·5 to 12·7 mm.; the cloaca from 1-1·4 mm. with the spicular tube joining it 0·475-0·53 mm. from the posterior end. The constriction joining the ejaculatory duct and vas deferens measures about 0·25 mm. long and 0·15 mm. broad.

Female: Length of anterior part is from 34 to 38 mm.; that of posterior part 15-18 mm. with a breadth varying from 0·45 to 0·54 mm. The vagina resembles in general that of *Trichuris ovis* with the difference that after the first two of three curves there is a dilatation proceeded by distal curves lined with spines. Eggs which are thick-shelled, measure from 0·055 to 0·058 mm. long and 0·024 to 0·026 mm. broad.

Discussion.—The males of the species resemble those of *T. parvispiculum* and *Trichuris discolor* for the short spicule and a pair of papillæ on the posterior part of the body but in the author's species the tip is truncated while it is rounded in the other two. In the author's species the spines on the sheath are fine, closely situated and uniform in distribution while in both the other species the spines are sparse in distribution and are triangular and blunt in the proximal part of the sheath. *T. discolor* has a sheath divided into a proximal tubular part and a bulbous distal part while the sheath in the author's species is club-shaped with a mouth-piece of the same length.

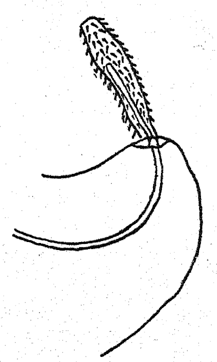

FIG. 2. *T. parvispiculm*; posterior end; male

The vagina in *T. ovis* has a uniform calibre throughout its course while in the author's species the middle curve is dilated.

Trichuris ovina sp. nov.

Specific diagnosis.—Trichurids resembling in general *Trichuris parvispiculum* and having spicular sheaths about 0·14 mm. long with mouth-pieces of approximately the same length; sheath studded with spines; spicule about 1 mm. long and ending with truncated margins; ejaculatory duct about three times the length of vas deferens.

Eggs measuring from 0·055 to 0·058 mm. long and from 0·024 to 0·026 mm. broad.

Host—*Capra hircus*; *Ovis aries*. Location—Cæcum; Locality—Punjab and the United Provinces.

Military Dehydrated Meat Factory,
Agra, M. M. SARWAR.
August 29, 1945.

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THE SPARING ACTION OF α-TOCOPHEROL ON CAROTENE

MOORE[1] first observed that ingestion of extra vitamin E increased the storage of vitamin A in the liver of rats and lengthened the time taken to deplete them of vitamin A. This work was extended by Hickman and co-workers[2] who showed that vitamin E enhanced the growth-promoting activity of vitamin A and more markedly of carotene, the action being attributed to the antioxidative action of vitamin E. Guggenheim[3] has confirmed the results using a modified method for the bio-assay. Recently, however, Gridgeman[4] reported that workers in his and another laboratory failed to observe any synergism between vitamin A and carotene on the one hand and vitamin E on the other. Though he did not doubt the operation of the synergism, he suggested that it may not manifest under certain conditions (private communication). During the study of factors responsible for the variation in response to carotene when dissolved in different oils, one of us (S.D.R.) obtained evidence of the synergism.[5] The results have now been confirmed on more extended levels of dosage of vitamin E.

A number of vitamin A-deficient rats were each given 0·8 μg. of β-carotene six days in the week and assembled into five groups of six rats, one group receiving no α-tocopherol and the others increasing quantities of it as follows: 0·03, 0·12, 0·50 and 2·0 mg. immediately after the carotene. The vitamins were dissolved in cocoanut oil free from carotene and vitamin E, the total oil intake being 100 mg. per rat at a time. The experimental diet consisted of 68 per cent. sucrose, 18 per cent. extracted casein, 10 per cent. brewer's yeast and 4 per cent. Osborne-Mendel salt mixture fortified with 1 mg. thiamine hydrochloride and 1 mg. of riboflavin per 1 kg. of diet and supplemented with 1 μg. of calciferol per week. The B vitamins were added since Hickman has pointed out the need for their adequate intake. The weekly gain or loss in weight was noted; the results are given in the accompanying table.

Effect of varying supplements of tocopherol on growth induced by 0·8 μg. carotene

Group	Tocopherol supplement mg.	Gain in weight in g. at the end of				
		1 week	2 weeks	3 weeks	4 weeks	5 weeks
1	Nil	1	−4	−7(1)*	−7(5)	All dead
2	0·03	0	2	5	4 (1)	2 (3)
3	0·12	0	4	5	5 (2)	7 (3)
4	0·50	6	8	10	11	14
5	2·0	3	3	4	8	12

*The figures in parenthesis indicate the number of rats that died during the experiment.

A dosage of carotene which was insufficient by itself to maintain life in rats became sufficient and promoted normal growth when administered together with tocopherol. The optimum tocopherol supplement appears to be the same as that observed by Hickman, *viz.*,

0·5 mg. per rat, though the diet used here was lower in fat.

Our grateful thanks are due to Prof. V. Subrahmanyan for his kind interest in the work.

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*THE ISOPOD PARASITE, *NEROCILA SUNDAICA* ON WEST COAST FOOD FISHES†

THE Isopod parasite, *Nerocila sundaica*, was observed quite commonly in a few of the important species of the food-fishes of the West Coast during the months of December 1944, January and February 1945. The species so infested were *Engraulis mystax*, *Otolithus ruber*, *Serranus gilberti*, *Pellona indica*, *Therapon jarbua* and *Sardinella fimbriata*. The parasite has been found attached at the angle of the pectoral fin in the case of the clupeoids and just posterior to the mandibular symphysis in the case of the perches and the jew fish. This position seems to be very protective enough for the parasite from the force of the currents and from the host.

DESCRIPTION

Head.—Slightly immersed in the first thoracic segment, length nearly half that of the width at its posterior margin. Eyes are large and darkly pigmented. The first antennæ is composed of six segments and second antennæ of equal length has ten segments. The maxillipedes form the floor of the mouth. The mouth appendages are modified for piercing and sucking.

Thorax.—The thorax has seven segments and they become progressively broader till the fifth segment from whence onwards they become little narrower. The thoracic appendages are modified as prehensile organs and form the main organs of attachment. The oostegites are found in the first six pairs of thoracic appendages and they are broad, subovate structures attached to the coxopodite of the appendages.

Abdomen.—The abdominal segments are narrower and clearly demarcated from the thorax. The telson is broad and sub-quadrangular in shape. The abdominal appendages are all biramous and lamellar, the rami of which serve as natatory and respiratory organs. In the male specimen the second pair of pleopods shows a special modification of the endopodite known as Appendix masculina. The uropod also is biramous.

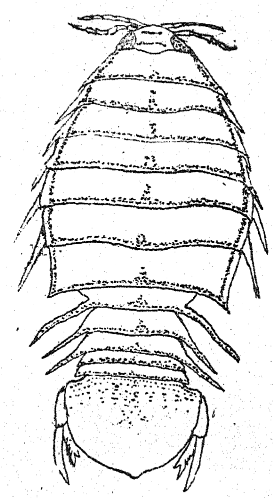

FIG. 1. The Parasite

The specimens vary in length from 1·8 cms. to 2·5 cms. and the width of the body is half as broad as the length. The colour is yellowish white with minute light spots at the posterior portion of the segments.

In specimens of *Engraulis mystax*, measuring 17 cms. and which were not attacked by the parasite, the condition of the gonads was in the second stage of development. In specimens attacked by the parasite and which measured up to 15·5 cms. there was only a trace of gonads. The Anchovies measuring 13 cms. and 14 cms. have been found to spawn in this period previously. As such the retardation of the gonadial development in these specimens 15 cms. long, may partly be attributed to the effect of parasitism of the Isopod.

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* Our thanks are due to Dr. B. N. Chopra, Director of Zoological Survey of India, for kindly confirming the identification.

† With the kind permission of the Director of Industries and Commerce, Chepauk, Madras.

REVIEWS

Industrial Oil and Fat Products. By Alton E. Bailey. (Interscience Publishers, Inc., New York, N.Y.), 1945. Pp. 735. Price $ 10.0.

The book under review is essentially intended to be a text on Oil and Fat Technology in its physical, chemical and economic aspects as it is practised to-day in America (U.S.A.). The author is the senior chemical technologist in charge of the Southern Regional Research Laboratory, U.S. Department of Agriculture at New Orleans, Louisiana and is well-known to readers of *Ooil and Soap* and *Industrial and Engineering Chemistry* by his valuable contributions in recent years to diverse aspects of modern oil technology ranging from studies in specific and latent heats of fusion of oils and fats to fundamental investigations on rancidity, antioxidants, tocopherol from cotton-seed oil, refining and deodorisation of oils, conditions governing production of iso-oelic acid in oil hydrogenation and catalytic rearrangement of glyceride structure in natural and synthetic fats.

The greater part of the book comprising sections C and D and forming sixteen out of a total of twenty-three chapters is devoted to a description and discussion of the commercially important oil and fat products and the processes used in their manufacture, the sections dealt with being cooking and salad oils, plastic shortening agents, butter and margarine, bakery products and confections, soaps, paints, varnishes and related products, and miscellaneous fat products like lubricants, illuminants, cosmetic and pharmaceutical oils, polishes and insecticides.

The unit processes in oil technology which are described in a systematic though brief manner comprise extraction of fats and oils by expression as well as solvent extraction, refining and bleaching, deodorisation, hydrogenation, soap production, fractionation of fats and fatty acids, fat splitting and esterification, polymerisation and isomerisation, including dehydration of castor oil and other ordinary oils, and finally solidification and emulsification of oils.

Much of what the author has presented is based on his own personal experience and as such is quite valuable. The author, however, has had the benefit in other matters of the advice and suggestions of about twenty professional colleagues including G. S. Jamieson, the well-known author of *Vegetable Oils and Fats*. Though the main purpose of the book is technological, the chemical and physical nature of fats and oils has not been neglected, the subject being reviewed in two preliminary sections A and B comprising the first seven chapters dealing with the structure and composition of fats and oils, reactions of fats and fatty acids, the physical properties of fats and fatty acids and the occurrence, production, composition and classification of the common fats and oils. A refreshing feature of the classification adopted in this book is the stimulating departure from the well-known grouping of oils into non-drying, semi-drying and drying oils and their rearrangement into the following groups: milk fats, lauric acid oils, vegetable butters, animal fats, oleic-linolic acid oils, erucic acid oils, linolenic acid oils, conjugated acid oils, marine oils, and hydroxy acid oils. This system of grouping is characteristic of the author's technological standpoint of the industrial utilisation of oils and fats.

However, in the part relating to pure chemical composition of fats and oils the treatment was not expected to be so thorough and occurrence of one or two errors of omission in that regard need not be surprising. For example, the statement on p. 13, line 9, about the occurrence of C_{20}, C_{22} and C_{24} saturated acids in nature, evinces regrettable ignorance of valuable contributions during the last decade and a half to rich sources of these acids in nature in the Sapindaceæ, Mimosæ and Moringaceæ seed group of fats. This does not in any way detract the valuable amount of technical material which is published here for the first time filling up notable gaps which have existed so far in such branches of the technology of the edible fats and oils as plastic shortening agents and bakery products and on the practical operations of refining, bleaching, deodorisation and hydrogenation as these are practised today with the most recent advances in their knowledge incorporated into practice.

The book on the whole is a valuable contribution to modern technological literature on oils and fats forming a tribute not only to the professional enthusiasm and achievements of the author but also to the scientific organisation and administration of the U.S.A. Agricultural Department and every technological institute would be well advised to secure a copy of this publication for the use of their technical staff.

P. RAMASWAMI AYYAR.
(MISS) R. J. IRANI.

Erosion in the Punjab—Its Causes and Cure. By Sir Harold Glover. (The Civil and Military Gazette, Ltd., Lahore), 1944. Pp. 143. Price Rs. 15-7-0 or 23*sh*.

Literature on the complex problems relating to soil erosion with specific reference to Indian conditions is none too plentiful. The Punjab has the distinction of being amongst the pioneer provinces in India to recognise the existence and urgency of soil erosion and to make a beginning with ameliorative measures. But, apart from papers in the professional journals and departmental reports, there was till now no publication giving a connected narrative of the considerable amount of work that has been systematically carried out in that province since 1939. This gap has been filled by the book under review, *Erosion in the Punjab—Its Causes and Cure*, by Sir Harold Glover, late Chief Conservator of Forests, Punjab.

The volume is divided into two parts. Part I, General, gives a brief description of the

country dealt with, the climatic, biotic and human factors influencing erosion, the consequences of erosion and lastly the methods recommended for the check of erosion. The second part is devoted to fairly detailed accounts of the varying conditions in the individual districts of the Punjab and contains summaries of the work done in them so far. These two parts are illustrated by a wealth of photographs (nearly 180 of them) which give the reader an excellent idea of what may be termed the qualitative side of the problem. The book, however, does not include specific quantitative data with regard to experimental plots, run-off volumes, weight of soil removed under defined conditions, the actual protection afforded by different types of vegetation and the like. But, the practical difficulties which a soil doctor—if the term be permissible, for erosion is definitely no more but no less than a disease—encounters in Indian rural communities, the administrative set-up that is required, the organisation of co-operative endeavour and more than all, the gradual building up of informed public opinion on which alone all soil conservation plans ultimately depend for success, all these are dealt with in an admirable manner with illustrative details which reveal a long and intimate knowledge of the problems handled.

A feature of the book is the large number of photographs. Anyone who has attempted to photograph large landscapes to bring out the details of topography and vegetation knows what a difficult job it is. The photographs which adorn this volume maintain on the whole a high standard, a few of them being taken from the air. The pictures tell eloquent tales which sometimes (for example facing p. 16, tap-root of a tree in an eroded field; p. 112, soil loss in an avenue) are startling. In fact, the photographs by themselves would form a very effective and entertaining background for a lantern talk on soil erosion to an Indian audience. The photographs are, unfortunately, neither numbered nor listed in a table of contents so that reference to them is not easy. The general level of these illustrations is so high that one wonders why such specimens as those facing pp. 14, 26, 28 (The Maili Village Co-operatvie Society), 91 and the like, have been included. These latter neither illustrate the text nor convey any significance to the central theme but only disturb the overall excellent impression made by the scores of other telling photographs.

The book carries a preface by His Excellency Sir Bertrand Glancy, a foreword by Sir James Penny and concludes with an appendix on the Bombay Presidency Land Improvement Scheme.

A few minor improvements would considerably add to the convenience of the reader. It is very curious that the "Contents" at the beginning of the book list the chapters but omit the paging. The lack of numbering of photographs has already been referred to. The second part of the book contains several official forms, model bye-laws, draft Gazette notifications and the like (pp. 95-106) which could with effect be divorced from the text and brought together in an appendix. In a volume so well illustrated, the absence of a few maps indicating the geography, rock and soil types and forest types in the area dealt with is a noticeable omission. One also notices occasional statements clothed in picturesque language as, for example, on page 16: "when the trees disappear, the rocks, heated by the direct rays of the sun, radiate out heat until the barren ravines are unbearable, the hot air rises and forces up the clouds which fail to drop their moisture." The cause and effect implied in this statement are still by no means proved beyond doubt and is best omitted from a book meant for the general reader. Two minor printing errors, noticed were *Magnifera indica* for *Mangifera indica* (p. 140), and *Acacia lencophlœa* for *Acacia leucophlœa* (p. 113).

The special value of a book such as Sir Harold's—written with the authority and perspective of many year's first-hand knowledge—is this. Land reclamation costs money. Thus, the cost of soil conservation in the northern Punjab districts alone is estimated by Sir Harold Glover to be about Rs. 53 lakhs a year for 15 years. The soil specialist of course knows that the expenditure of these large sums of money is not only good investment but is the bare minimum insurance against the total loss of the essential capital of the rural community—the soil. For the success of anti-erosion measures, it is indispensable that Mr. Average Citizen be convinced of this for, as Sir J. D. Penny observes in his foreword, "..... in the last resort the success or failure of soil conservation measures will depend on the extent to which they enlist the assistance both of nature and of the humble tiller of the soil and the still humbler shepherd and goat-herd". In the absence of knowledge of the facts of the problem neither the money required nor the requisite co-operation of the villager would be forthcoming. Sir Harold Glover's book should be of great help—quite apart from its value as an objective record of valuable soil reclamation work in the Punjab—in opening the eyes of a complacent public to the menace of soil erosion in the Punjab and in convincing an even wider public that erosion is a deadly but curable disease.

The Exodus from Travancore to Malabar Jungels. Surveys by K. G. Sivaswamy and six Doctors. (Servindia Kerala Relief Centre, R.S. Puram Post, Coimbatore), August 1945. Pp. 39 + iv. Re. 1.

Unable to bear the privations in their native homes in Travancore brought about by famine, 15,000 settlers travelled long distances to the hilly parts of Malabar which have remained uncultivated for centuries. Migration was preferred as being the lesser of two evils; partial starvation at home or cultivation in malarial tracts infested with wild animals. The heroic struggles of these settlers against malaria and wild animals are described in this pamphlet. Medical and nutritional surveys, carried out with considerable difficulty, are also included. About 2,000 of the settlers died of malaria and malnutrition while some returned home broken in health and fortune. Many among the re-

maining are dragging on a miserable existence, with impaired vitality and heavily indebted to money-lenders. An appeal is made for effective and immediate relief, especially an unlimited supply of anti-malarial drugs. Anti-malarial operations, like aeroplanes spraying with insecticides, are also suggested.

Regarding the etiology of certain diseases in these settlers, it is wished that the authors have made less audacious statements. "Rice firmentation (fermentation) and these organisms may be a prominent cause of cirrhosis of the liver" (p. 15); "Want of animal protein in the diet also increases anæmia and particularly nervous diseases" (p. 16); "Their eating preserved foods of the previous night may have some relation to choleraic diarrhœa" (p. 32). These statements appear all the more glaring when one considers the caution exercised about tapeworm, a disease "attributed to the eating of dead cattle. This requires medical investigation" (p. 18). The expression "nitrogenous proteins" is rather revolting. Except for these minor blemishes, the book is an admirable document containing much material painstakingly collected. The book is priced too high. S. RANGANATHAN.

Report of the Scientific Advisory Board for the Year 1st January to December 1944. Issued under the authority of the Governing Body, Indian Research Fund Association, New Delhi. (The Secretary, Governing Body, Indian Research Fund Association, Secretariat, New Delhi.) Pp. 188. Re. 1.

The Annual Report of the Scientific Advisory Board for 1944 records another year of successful research despite the handicaps imposed by war conditions. Reports of the Advisory Committees on Cholera, Malaria, Nutrition and Plague are also incorporated. Work on the treatment of cholera with sulphaguanidine, and the statistical evaluation of the degree of protection conferred by anticholera inoculation form the principal researches under cholera. Results of detailed studies in the prevention and control of malaria, and large-scale field trials with various insecticides (including D.D.T.) and mosquito repellents are included. The comparative value of different sulpha drugs in the treatment of plague and the peculiar mode of spread of plague in certain rural areas in the Madras Presidency were investigated.

A good number of the researches financed by the I.R.F.A. are concerned with nutrition; 16 out of 42 enquiries relate directly to nutrition while a few of the schemes under "Other Researches" have an indirect bearng on nutrition. It is not surprising, therefore, that the bulk of the Report is devoted to this subject. A document of 18 pages dealing with the practical and public health aspects of nutrition, prepared for the benefit of the Public Health Committee of the Health Survey and Development Committee of the Government of India is also included. The findings of the Sub-Committee on "Nutritional Requirements" form a useful addition as also those of the Soyabean Sub-Committee. The latter conclude that "the nutritive value of soyabean, in comparison with that of other common Indian pulses is not such as to justify, from the standpoint of human nutrition, the immediate encouragement of the production and consumption of soyabean on a wide scale in India." The budget allotments for the various enquiries and staff of the I.R.F.A. and for the publication of the *Indian Journal of Medical Research* appear towards the end of the Report.

Those interested in the progress of medical research in India will find the Report useful and informative. S. RANGANATHAN.

The Indian Cotton Textile Industry 1944 Annual. (Published by Messrs. Gandhi & Co., Publishers, Jan Mansion, Sir Pheroz Shah Mehta Road, Bombay), June 1945. Pp. 150. Price Rs. 5.

The Annual represents a valuable contribution to the knowledge and objective study of the Cotton Textile Industry of this country. In layout and format, it closely follows its predecessors.

As usual the volume reviews the major domestic events in the industry and gives a wealth of valuable statistical data intelligently presented and takes the reader through the long and eventful history of the industry with remarkable brevity. Accurate and exhaustive statistical data plays an important role in all economic and industrial planning and in this aspect Mr. Gandhi's contribution is indeed praiseworthy.

The book reproduces some of the more important Textile Control Orders and also gives an exhaustive list of other control orders affecting the industry, which lends to the volume special topical interest. It presents in a lucid manner a brief history of the evolution of the Textile Control touching all its important aspects, the intricate problems it has had to face particularly of distribution and how they had to be tackled and solved. The book also publishes the recent Textile Industry (Control of Production) Order and explains its purpose and benefits. While all may not agree with the editor about the benefits of the scheme to the industry, there can be no doubt that it is an admirable emergency measure which has helped to relieve the present cloth famine in the country. The author's detailed survey of post-war problems facing the industry is of special interest, particularly his reference to the considered views expressed by the Chairman of the Bombay Millowners' Association on the obligations of the mills and the Government to the industry if it is to stand on a sure foundation to withstand the foreign competition.

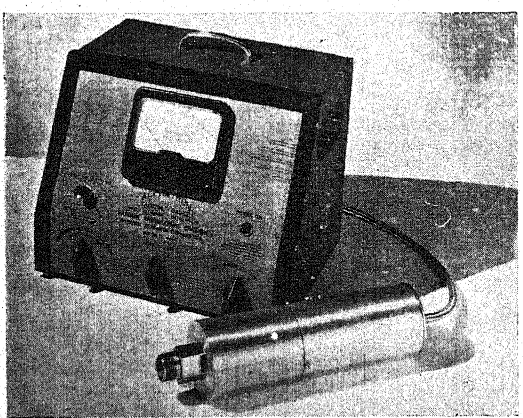
The volume annexes at the end two appendices, one dealing with the subject of cotton cultivation, its development and problems and another with the handloom industry and its potentialities during the post-war period supported by fresh extracts from the Report of the Fact Finding Committee (Handlooms and Mills) released in 1943.

On the whole the book is very interesting and informative and should be particularly useful in the field of post-war planning.

B. G. R.

SCIENCE NOTES AND NEWS

The Alphatron is an all-metal ionization gauge with continuous linear response to 10 mm. total pressure. The ionizing agent is a stream of Alpha particles emitted by a radioactive source, which permits operation at any pressure, including atmospheric, without damage to the gauge. The steady emission



characteristic of the radioactive element and advanced amplifier design insure great stability and reduce needle flicker to a minimum. The model produced at present by the National Research Corporation in Boston covers from 0 to 10 mm. in three ranges, all reading direct pressure. The ranges are 0 to ·1 mm., 0 to 1 mm., and 0 to 10 mm. Pressures can be read to one per cent. of full scale reading in each case. The gauge is ideal for measuring pressures of gases other than air, such as argon, water vapour and hydrogen, as the linear response of the gauge holds true regardless of the atmosphere.

The Eleventh Annual Meeting of the Indian Academy of Sciences will be held at Udaipur from 26th December to 28th at the invitation of the Government of Mewar. The National Academy of Sciences is holding its annual meeting jointly with the Indian Academy.

The Sir C. R. Reddy National Prize has been awarded by H. E. the Governor, Chancellor of the Andhra University, to Prof. C. V. Chandrasekharan working at the Yerkes Observatory in America.

Sir C. P. Ramaswami Aiyar, Dewan of Travancore, will address the annual Convocation of the Patna University scheduled to be held on November 24th, 1945.

The Convocation of the Annamalai University will be held on 27th November 1945; Sir Norman Strathie, Adviser to H. E. the Governor of Madras, will address the Session.

Sir Mirza M. Ismail has accepted the invitation of the authorities of the Benares Hindu University to deliver the Convocation Address on 2nd December 1945.

Mr. K. M. Pannikar, Prime Minister, Bikanir, has been invited to deliver the Convocation Address of the Andhra University on 6th December 1945.

Sir C. R. Reddy has kindly consented to address the Convocation of the Utkal University scheduled to be held on the 12th December 1945.

In connection with the forthcoming Session of the Indian Science Congress to be held in Bangalore from the 2nd January to 8th January 1946, the Local Committee has decided to bring out a Souvenir in an attractive form with suitable illustrations. About 2,000 copies will be printed and distribtued amongst the delegates. Those intending to insert an advertisement in the Souvenir are invited to correspond with Mr. B. R. Subba Rao, M.A., Dip.-in-com., Convener, Publication Sub-Committee, Indian Science Congress Session 1946, Central College, Bangalore.

The 33rd Session of the Indian Science Congress will be held in Bangalore from the 2nd to the 8th January 1946. The problem of accommodation in Bangalore being very acute, the Local Secretaries advise that arrangements should be made well in advance in the different hotels and students' hostels. Bangalore during January is comparatively cold; the delegates are advised to provide themselves with warm clothing. There will be full-day excursions (if sufficient number of delegates participate) to Iron and Steel Works and Paper Mills at Bhadravati, the famous Jog Falls, Belur and Halebid Temples, Mysore, Krishnarajasagara, Seringapatam, Sivasamudram Hydro-Electric Works, and Kolar Gold Fields.

Numerous students and scientists, who have been benefited by the brilliant researches of Rai Bahadur Dr. S. L. Hora, met in Calcutta recently and decided to celebrate the Silver Jubilee of his first scientific publication (September 1920). For celebrating the occasion a comprehensive programme is being chalked out but its successful execution will largely depend upon the funds that could be collected for the purpose. Those wishing to associate themselves with this function are invited to remit their donations to Dr. Nazir Ahmad, Hon. Secretary, Jubilee Committee, 13, Ballygunge Circular Road, Calcutta.

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SCIENTIFIC RESEARCH IN NATIONAL PLANNING

THIS war has proved beyond doubt that human valour and determination cannot compensate for scientific and technical efficiency, and that a nation with a low *per capita* income and limited industrial development, even though large in numbers, has little chance of honourable existence in this world. The aim of every post-war reconstruction in India, therefore, should be the removal of these two weaknesses—a low *per capita* income and limited industrial development.

It will be idle to ignore the fact that there are powerful leaders in India who have been so impressed by the evils of the modern world that they do not hesitate to declare that the introduction of the Western methods for increasing our national income should be resisted and that it is no business of the State to help scientific and technological development. They would prefer the culture of cottage industries, peasant farming, and living on subsistence level with its inevitable doses of famine and pestilence to the immense wealth but inhuman greed of modern societies. It is hoped that they would soon recognise, now that the Fascist world has tumbled down, that the powerful tools of science are capable of doing immense good if handled for the benefit of humanity; that in these days of rapid communications, we cannot live in isolation from the rest of the world even if we wish to do so; that life in India will be stagnant if we run counter to the characteristics of the present age which consist in applying the principles and products revealed by scientific research to industry and agriculture.

It is also unfortunate that our powerful industrial magnates and *entrepreneurs* do not always believe that scientific and technical research is necessary for the industrial development of a country. They consider that all that is needed is to decide on general grounds, if the country has the potential resources in raw materials, power and transport facilities which will justify the establishment of any particular industry, and then import into the country the necessary machinery and experts for the purpose. They are in favour of providing such technical education which will enable the industry to be run by indigenous talent after a period of probation under foreign experts; but they would stop at research as being more in the nature of a luxury. To them the history of the dyestuff industry should be an object lesson. The first synthetic dye was made in England by Perkin, but the industry soon found a congenial home in German soil. In Germany, the practical outlook of businessmen was enthused by that faith in scientific knowledge which came from first-hand knowledge. Thus twenty long years of painstaking research were necessary at a cost of more than a crore of rupees before Bayer's process for the synthesis of indigo could be commercialised; but once it was done, the fate of the natural indigo of Bihar was sealed and it disappeared from the world's market in another twenty years. The attitude in Great Britain was one of complacent "wait and see"; and the result was, that when the first world war broke out, she had no dyestuff industry of any importance. As that war

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progressed, it was soon realised that this dependence on Germany for dyes was an intolerable weakness of the British chemical industry. Modern war depends for its successful prosecution on an abundant supply of a large variety of chemicals; and a dyestuff and fine chemical industry must be considered an integral part of every defence programme. The British Government, under Lloyd George, took immediate and far-reaching steps. Beginning with a large subsidy for the formation of the British Dyestuff Corporation, millions of pounds were spent on developmental research in every branch of the industry. Later on, the importation of dyes and even intermediates were prohibited. As a result, Sir Gilbert Morgan could claim in 1939 with justifiable pride that out of the five most fundamental discoveries in dyestuff chemistry since 1921, the world owed three to British talent. In this war, the British Dyestuffs factories not only produced their home requirements, but had in addition a considerable export trade.

In India we are now very anxious to increase the productivity of the soil by use of synthetic fertilisers; and ammonium sulphate factories on a large scale are being built in Travancore and Bihar. It is, therefore, of topical interest to recall that exciting venture of the late Prof. Haber when in 1909 he demonstrated before the Badische Chemical Engineers that it is possible to obtain small quantities of ammonia by direct combination of nitrogen with hydrogen. Millions of pounds had to be spent before this discovery could be exploited commercially; and today, synthetic ammonia, apart from its value in war, constitutes the biggest single item in the fertiliser industry with an annual production of more than 150 crores of rupees. It is also a proof that the direct return of one fruitful piece of long-range research pays back many times over the cost of ninety-nine which may not find useful application. The conviction has now become universal that, a nation which habitually applies scientific method and knowledge to industry and agriculture, can only seize the more spectacular achievements of science in its economic life. "No nation can also depend only on the efforts of other nations for the purpose of promotion of knowledge. This is not only because such dependance is an ignoble parasitism, but also because in the field of international relations, no less than in national life, the power that comes from knowledge comes from its early and rapid use and from close contact with men who have created such knowledge."

It is, therefore, a matter of considerable satisfaction that the Report of the Industrial Research Planning Committee, appointed by the Government of India, contains a bold five-year programme for the development of industrial and scientific research, at an estimated expenditure of Rs. 6 crores. The building and equipping nine specialized laboratories, including a technological institute on the lines of the Massachusetts Institute of Technology; a two crores of rupees grant for strengthening the scientific departments of India's eighteen universities and the training of seven hundred research workers in five years—these are some of the recommendations made by the Industrial Research Planning Committee.

In its Report the Committee recommends the setting up of a national research organisation to be called the National Research Council which would be authorized to initiate the Five-Year Plan immediately.

Recurring annual expenditure is estimated at 2 crores of rupees and the Committee recommends that half this amount be met by a grant from the Government and the other half by a proposed cess on industries, including railways.

The Committee recommends that the National Research Council should consist of representatives of scientific bodies, universities, industry, labour and administration, with the Government of India's Member for Planning and Development as *ex-officio* President. The Council will organize and maintain national laboratories and specialize research institutes; stimulate and encourage research activities by Industry and in co-ordination with all existing research institutes and departments of Government, undertake the planning of research programmes on a nation-wide basis. The Council will also serve as a national trust for patents and will set up a Board of Standards and Specifications.

Apart from the establishment of a National Chemical and a National Physical Laboratory, which is recommended at an estimated cost of 40 lakhs of rupees each, the other specialized laboratories proposed to be set up are, in order of priority, those for Food Technology, Metallurgy, Fuel Research, Glass and Silicate Research, Oils and Paints, Leather and Tanning, Industrial Fermentation and an Electro-Chemical Institute.

Industries will be encouraged to set up their own research associations on a corporate basis and the expenditure incurred on research will be exempted from income-tax assessment.

It is also proposed that Research Councils on the model of the National Research Council be set up in all Provinces and major States.

A small executive body called A Research Board will be responsible for the administration of the Council's work. The Board will prepare comprehensive plans of research programmes and will take an active part in the establishment of research institutions by industries.

We hope the Government of India will give due consideration to this report and funds will be made available for industrial and scientific research on adequate scale in the near future.

POONA UNIVERSITY

THE announcement by the Government of Bombay to give effect to the recommendations of the Maharashtra University Committee in due course on certain terms and conditions is most welcome.

The Bombay Presidency Education Conference under the presidency of Sir Narayan Chandavarkar adopted a resolution in favour of regional universities for the presidency as long back as 1917. In 1924, the Committee on University Reform, presided over by, Sir Chimanlal Setalvad, recommended the creation of universities in Maharashtra, Gujerat, Karnatak and Sind, and reported that conditions were ripe for the setting up of some form of university for Maharashtra in Poona. In 1933, as a result of representations made by certain leaders of Maharashtra, a conference of educationists and representatives of other interests was convened to discuss the policy of gradual establishment of regional universities in the Province of Bombay. As this conference could not come to unanimity of opinion in favour of any scheme, nothing further was done. In 1941, a representative deputation waited on the Adviser to H.E. the Governor of Bombay to press the question of a University for Maharashtra and as a result, a committee, presided over by the Right Honourable Dr. M. R. Jayakar, was appointed to consider the question of the establishment of a University for Maharashtra in all its aspects.

The Jayakar Committee did monumental work for a period of over a year and submitted a report to Government which will stand for a good length of time as a document of great value. The Committee has considered in great detail all types of university education and evolved a type which incorporates many good features of various types with due deference to the requirements of Maharashtra and to the several financial difficulties. The Committee has recommended the establishment of a University for Maharashtra in Poona, to be called "The University of Poona". At Poona, there is to be built up a strong teaching and research centre. As far as possible, most of the post-Intermediate work is to be done in Poona with the pooling of the resources of all the existing institutions. Colleges outside Poona which are situated within the Marathi-speaking area of the Province should teach up to the Intermediate stage. The University is to be of an affiliating type only up to the Intermediate stage but there is a proviso for a large measure of University supervision even at this stage. This is most desirable and very welcome. The teaching for higher classes is to be the direct responsibility of the University. Special provision is to be made for the systematic supervision over the lodging of students. There is to be an Appointments Board also. One important aspect of the work of the University will be the introduction of Marathi as a medium of instruction and examination. This is a feature which will be watched with interest all over the country. The several authorities of the University are similar to those elsewhere. A special feature, however, is the fact that elections have been reduced to a minimum and the academic and non-academic bodies are clearly defined.

Poona is one of the largest educational centres in India and has several well-established colleges and research institutions. The contribution of the several scholars from Poona to the advancement of knowledge is well known. The climate of Poona is very conducive to intensive work for the greater part of the year. Marathi is one of the few well-developed languages of the country with a good and growing literature. The establishment of a university at Poona is, therefore, most appropriate. We look forward to its establishment as a welcome step for the advancement of higher education and research in the Province of Bombay in particular and in India in general. We have no doubt this will relieve the great strain that is placed on the University of Bombay which is now catering to the vast and varied requirements of the whole Province and Sind.

THE IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

THE IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY recently celebrated the centenary of the Royal College of Science, one of its constituent colleges—the other two being the Royal School of Mines and the City and Guilds College. The Royal College of Chemistry, the original of the Royal College of Science, was sponsored at a meeting held on July 29th 1845, in the early days at the dawn of an Industrial Age. It has been staffed by such eminent scientists as Sir W. H. Perkin and Sir William Tilden, who made striking and fundamental contribution to our knowledge in pure and applied chemistry. The college has played a notable part in winning the last War, and is looking forward to getting into its peace-time stride, and helping British Industries to re-establish themselves in the world markets. "The fundamental need is the highest degree of efficiency in our production. No exporter can win markets unless the quality, price and design enable him to sell the goods. Price is a measure of our efficiency. We cannot and must not try to attain a low price by cutting wages. We must attain it by increased efficiency and cutting costs."—This is the ardour with which the College enters its second century.

GOLDEN JUBILEE OF THE DISCOVERY OF X-RAYS

THE Travancore Medical Association celebrated the Golden Jubilee of the discovery of X-rays on Monday, the 5th November 1945. *Sachivottama* Sir C. P. Ramaswamy Iyer, who presided on the occasion, said: "The whole question of X-rays and all that they mean is a matter which cannot escape the attention of any one who is studying the working of the Universe either from the spiritual or the physical aspects. The X-rays and cosmic rays are the result of the perpetual disintegration that goes on in the Universe which our ancients connoted by the expression *Pralaya*. The emanation that causes the birth of things is action or manifested energy. Matter is now disputed to be not matter at all. The whole world is immaterial, it is *Maya* in the transcendental sense. To our ancients this truth came as part of intuition. The question that comes to most of us is, 'Is vibration and not substance, the ultimate fact of the universe, the *Nadabrahma* of which our ancients spoke?'"

Dr. H. Parameswaran, surveying the progress of "X-rays in Industry", referred to the development of the X-ray technique during the past fifty years and its applications to the identification of precious stones, detection of crimes and examination of minerals and castings.

Dr. C. S. Venkateswaran briefly reviewed the fundamental role of X-rays in physics and chemistry. By the discovery of X-rays, Prof. Röntgen placed in the hands of scientists a radiation having a wavelength less than one-thousandth of the visible light. When a beam of X-rays falls on matter, every atom is covered by a full wave. It may truly be said that the atomic age of which we hear so much to-day was ushered in by the discovery of X-rays. In its wake followed the discovery of the electron, the atomic theory and indeed all the fundamental facts which form the basis of Modern Physics. By the irradiation of matter with X-rays, two things may happen. It may result in the ejection of the outer electrons. The study of these photo-electrons has contributed greatly to the development of the atomic theory. Alternately X-rays may set the electrons of the atoms in vibration; thus every atom becomes a secondary source of radiations. The study of these secondary X-rays helped to investigate not only the number of electrons in an atom but also how they are distributed in space. In the same way, it afforded a deep insight into the arrangement of atoms in molecules and of molecules in condensed media. By far the most extensive field of its application has been to the investigation of the atomic arrangements in crystals, X-rays reveal not only the perfection in the internal architecture of the crystals but also the surface and volume imperfections of even the slightest degree. X-rays thus touch the heart of matter. These fields of investigations are likely to be extended a hundredfold by the recent improvements in X-ray technique by means of which rays having a wavelength as short as γ-rays could be produced in the laboratory. He also referred to the study of molecular vibrations by X-ray methods—a field full of promise for the future.

Dr. A. O. Jacob dealt with the surgical and therapeutic values of X-rays and the manifold uses to which they are put by medical men for diagnosis and treatment of tumours and eruptions.

Sir C. V. Raman at the outset paid a glowing tribute to Conard William Röntgen, the greatest benefactor of mankind. Speaking of the role of pure science and scientists, Sir Raman said: "Too often to-day the world is separated into pieces by national and international hatreds, antagonisms and war. Science alone among the forces living to-day brings us together. It is the power of man to discover a great truth by intuition that raises him in his own estimation. Thus, for example, it was a supreme triumph of inuition that led Prof. Louis de Broglie to discover the dual nature of matter. Intuition cannot, however, be a substitute to experimentation. Nature reveals her great secrets only to her devout worshippers like Prof. Röntgen. The man of science, like a true devotee, lays his *Atman* at the feet of the deity. Every day and, in fact, every hour, his life is a supreme act of sacrifice.

The greatest leaders of the world, the apostles of humanity, are the men and women like Röntgen and Mme. Curie, who made a free gift of their discoveries to the whole humanity. The true justification of science, if there is any justification, is that it binds the nations of the world together and not separates them and he who forgets this truth is unworthy of the name of scientist.

The discovery of X-rays is an outcome of the supreme courage to do and dare. It heralded a new era of scientific progress. It was a wonderful reward which came to a man seeking in the solitude of his laboratory to understand the secrets of Nature. By this discovery the old world was abolished and a new world ushered in where the hope of mankind was to be brightened and his suffering lessened. It is in fact the one discovery, which produced a thrill in the whole world of science and fired the imagination and enthusiasm of a whole generation of workers. In its biological effects X-rays gave a meaning to what is meant by life. The contributions to physics and chemistry are profound and affected every branch of science. We may regard the modern atomic age as the true child of Röntgen's wonderful discovery fifty years ago."

C. S. VENKATESWARAN.

LETTERS TO THE EDITOR

PRODUCTION OF THE *LIGHT-EFFECT* IN CHLORINE UNDER ULTRA VIOLET

Previous results[1] regarding the current decrease Δi on irradiation of chlorine and other gases, subjected to a silent discharge in Siemens' tubes (also in semi-ozonisers), referred to various spectral regions from 7,100 to about 3,700 Å, the short wave-length limit for glass and also to X-rays from a Coolidge tube with a tungsten target.[2] This phenomenon has now been observed under the ultra-violet.

An all-glass ozoniser, about 100 mm. long, 50 mm. in diameter and 5 mm. width for the annular space, had a 1·5 mm. thick quartz window cemented on one end. It was filled with chlorine at 300 mm. pressure and excited by potentials varied by 0·3 kV at a time in the range 4 to 6 kV (r.m.s.) at 50 cycles frequency, and irradiated in the *end on* position. The threshold potential of the system[3] was about 4·2 kV. The inner electrode of the ozoniser was filled with a concentrated solution of potassium permanganate in order to absorb all light; the ozoniser was also screened against external light by wrapping in black paper, except at the quartz window. The gas under the discharge was therefore, irradiated only by a narrow beam, of the size of, and along, the annular space. The appreciable values for the *light-effect* expressed as a percentage of i the conductivity in the dark $\%\Delta i$ (*vide infra*), despite this restricted irradiation, indicate therefore, the large magnitude of this phenomenon producible under optimum conditions.

During one of the series of observations made with a 100-watt incandescent (glass) bulb as a light source, $\%\Delta i$ first increased from 22 to a maximum of 24, and then decreased to 13 as V, the applied potential, was 4·5, 4·8 and 5·6 kV respectively. Superposition over the quartz window of 2 mm. thick glass plates showed that the corresponding $\%\Delta i$ diminished in accordance with earlier general results for the influence of intensity on the *light-effect*.[4,5] Thus, for example, with two glass filters and the quartz, $\%\Delta i$ decreased from 16 to 11, as V increased from 4·2 to 5·6 kV.

Using a large-size quartz mercury vapour lamp and only the quartz window, $\%\Delta i$ was 35 and 42 respectively at the values of V mentioned above; $\%\Delta i$ was a maximum, *viz.*, 55 at 5·1 kV. Results were interesting when the ultra-violet was cut off appreciably, by the addition of a 2 mm. glass over the quartz. The $\%\Delta i$ with the above light-source and potentials falls to 17 and 16 respectively, with a maximum of 25 at 5·1 kV. These values are sensibly similar to those observed under the visible as indicated above. This is further brought out by the fact that the $\%\Delta i$ with two glass filters and the quartz was about 23

as a maximum; and decreased with V on either side, being, *e.g.*, 17 and 13 at 4·5 and 5·6 kV respectively. It follows, therefore, that the relatively high values for $\%\Delta i$ with only the quartz window, may be attributed to the high frequencies in this radiation, and not so much to the much greater over-all intensity of light from the mercury lamp compared with the bulb. It is also seen that the frequency is a more important determinant of this *light-effect* than the light-intensity; and that, with a strong radiation, a change of intensity does not diminish $\%\Delta i$ appreciably, as long as the light-frequency is substantially unaltered.[5] These results are also in accord with an earlier finding, that $\%\Delta i$ attains to a maximum near the threshold potential;[6] it would now appear that the position of this maximum in respect of V, depends upon the nature of the exciting light.

Chlorine absorbs selectively chiefly in the region (which is the source of its colour), from 6400 Å or perhaps a little longer, to about 2500Å with a pronounced maximum at 3340Å;[7] it also absorbs between 1900 to 1560 Å.[8] The much greater *light-effect* now observed in the ultra-violet may, therefore, be associated with the circumstance that it also represents largely the characteristic absorption spectrum of chlorine, and especially that part in which comparatively, the extinction coefficients are high.[7,8,9] On the short-wave side of 4785Å which is the convergence limit, the absorption by chlorine is *continuous*.[7,8] From Franck's well-known theory[10] of light absorption by especially diatomic molecules, which has been abundantly verified, it is extremely likely that a primary effect of irradiation of chlorine in the above regions is the production of normal and excited atoms of chlorine in the discharge space. These have a large 'electron affinity';[11] at a given V, the corresponding electronic velocity U- is, therefore, expected to be reduced, due either to electrons attaching to chlorine atoms, so as to give atomic ions of reduced mobility;[12] or/and U- might decrease owing to a viscous drag by the atmosphere of electro-negative chlorine atoms.[13] It has been shown by the writer that U- determines the discharge current i.[14] The occurrence, therefore, of a current decrease Δi under irradiation, which constitutes the *light-effect*, follows.

It may be emphasized, however, that the production of the *light-effect* in air and hydrogen in the visible;[1] that $\%\Delta i$ in chlorine in the yellow, *e.g.*, radiation from a sodium vapour lamp (whose absorption by chlorine is minimum) is as much as 15 per cent., which is greater than a relativity more absorbed and intense red band, *viz.*, 6100 to 7100 Å, *viz.*, 3·5 per cent.; and especially the observation that at 7700 Å and longer, where absorption by chlorine is presumably negligibly small, Δi is about 2-3 per cent., suggest that the *light-effect* may not be entirely a consequence of selective light-absorption, but also a frequency or a quantaic phenomenon.

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Benares Hindu University,
October 16, 1945.

1. Joshi, "Presi. Address," *Chem. Sec.*, *Indian Sci. Cong.*, 1943. 2. —, *Curr. Sci.*, 1944, **13**, 278. 3, —, *Nature*, 1944, **154**, 147. 4. Deo, *Indian Journ. Phys*, 1944, **18**, 80-85. 5. Joshi, *Curr. Sci.*, 1945, **14**, 36. 6. —, *Proc. Indian Acad. Sci.* (communicated). 7. Halban and Siedentopf, *Z. Physik Chem.*, 1922, **103**, 71. 8. Cordes and Sponer, *Z. Physik*, 1930, **63**, 334. 9 Joshi and Deo, *Nature*, 1943, **151**, 361. 10. Franck, *Trans. Faraday Soc.*, 1926, **21**, 536. 11. —, *cf.*, pp. 179, 182, 186. Foote and Mohler, *Origin of Spectra* (New York, 1922). 12. Townsend, *Electricity in Gases* (Oxford, 1915). 13. J. J. and G. P. Thomson, *Conduction of Electricity Through Gasses*. 1 (Cambridge, 1928). 14 Joshi, *Trans. Faraday Soc.*, 1929, **25**, 125-128; 141, 142.

MAGNITUDE OF THE EARTH'S CHARGE

THE earth's charge Q, has been estimated to be $4 \cdot 5 \times 10^5$ coulombs of negative electricity. But this value has been computed on the basis of a homogeneous, internal geophysical structure, merely giving rise to an electric field of the order of 100 volts per metre at the earth's surface, this having been multiplied by the square of the earth's radius to give the foregoing value. It will, however, be seen that such an assumption is erroneous in the light of modern theory.

It is generally agreed that, before it assumed the present structure,[1] the earth was one rapidly rotating spherical mass of metallic fluid which later cooled at the surface to form an upper crust of thickness approximately 2,900 km., and the still hot internal residual core of radius 3,500 km., there being a spherical "layer of discontinuity" several kilometres thick between the two. Assuming, in accordance with the modern view in general, that the earth's magnetism is caused by the rotation of a negatively charged core,[2] and noting that the earliest records do not show that the net value of the field generated has changed to any extent since then, we may state that the core is rotating at almost the same angular velocity as at the time of the transformation; that the crust is rotating at an angular velocity which could have been modified only by the change which took place in its density; and that the angular momentum of both must be relatively the same as before.

It is known that the density of the earth's crust is 5, that of the core[3] is 8, and that the angular velocity of the crust is 7×10^{-5} radians per second. Knowing the volume of each and hence the mass m, the angular momentum is easily calculated. Equating the two we obtain 22×10^{-5} as the angular velocity w, of the core.

Since the earth's magnetic axis is symmetrically inclined at an average angle of 20° to the geographic, we must now suppose that the core is rotating independently of the crust and around a different axis. Also, the magnetic axis (produced) is situated at well-defined points in the north and south latitudes of the earth's surface. This would indicate that the magnetic *axis itself* is rotating, along with the earth, about its midpoint near the earth's centre. To an observer located on the earth, therefore, the entire earth's core must, for the greater part, rotate with the same angular velocity w, as we have obtained above. Now

the magnetic potential M, of a point[4] with polar co-ordinates r, θ with reference to a charged sphere such as the one in the earth's interior, is given by

$$M = \frac{Qwa^2 \cos\theta}{5cr^2}$$

where a is the radius of the sphere (the core), and c is the velocity of light. But $M = Hr$ in which H is the average value of the computed earth's magnetic field. Hence

$$Q = \frac{6cHr^3}{wa^2 \cos\theta}$$

and substituting appropriate values for a point near the core's pole, we have $Q = 2 \cdot 5 \times 10^{14}$, and not $4 \cdot 5 \times 10^5$ coulombs as is commonly assumed.

Again Petrucci[5] has shown that the earth's charge is a variable quantity, and that it changes directly as the atmospheric potential gradient. But since the latter may vary from one to four times its basic value in the course of a day, we may conclude that the earth's charge also varies from one to four times the above value. It is important to note that *there will be a strong electrostatic field* at the surface of the earth's internal core of Q divided by the square of the core's radius, namely, 6×10^8 volts per cm. which must undergo a similar periodic variation in magnitude.

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Bombay, ALFRED B. ARLICK.
October 8, 1945.

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NEW ULTRA-VIOLET BANDS OF MERCURY IODIDE

THE ultra-violet bands ascribed to the mercury iodide molecule by various investigators were recorded in a previous paper[1] dealing with the analysis of two of these band-systems. Further investigations using transformer and high-frequency oscillator discharges through mercury iodide vapour reveal the existence of three new systems which have not been reported previously. They lie in the regions λ 2550-2500, λ 2435-2385 and λ 2345-2300, and may be designated as F_1, F_2, F_3-systems respectively. F_1 comprises of about twenty red degraded bands some of which have intense and sharp edges towards the violet. F_2 consists of a succession of closely spaced bands degraded to the red with the interval between successive bands diminishing towards the region of longer wave-lengths. F_3 has the resemblance of the brief system of mercury bromide analysed previously[2] and consists of about fifteen diffuse and mostly headless bands. The analysis of these systems and their correlation with the other known bands of the HgI molecule will be dealt with in detail elsewhere.

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November 28, 1945.

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OSCILLOGRAMS OF VALVE CHARACTERISTICS

IN the course of a study of the dynamic transfer characteristics of radio valves, by means of the cathode-ray oscillograph, a few interesting features were observed, which are described herein. In this method the signal input (50 C.P.S. and 1,000 C.P.S. sine wave in our case) is applied to the control grid and to the X-plates of the oscillograph, while the anode output is applied to the Y-plates.

It is in general recognised that the dynamic ($e_g = i_p$) characteristics become looped or closed curves, if the load impedance has a


FIG. 1

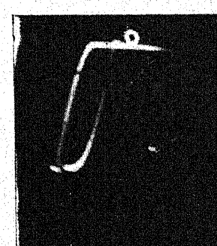
FIG. 2

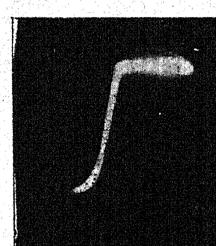
FIG. 3


FIG. 4


FIG. 5


FIG. 6

reactive component, when phase changes are introduced between the X and Y components of the variables. But our studies reveal that even if pure resistance are used in the anode and grid circuits, closed dynamic curves can be obtained, if the grid resistance is higher than certain maximum values. Under these conditions when the grid charge leaks away but slowly, the response of the plate voltage can be delayed, developing a sort of hysteresis effect as shown in Figs. 1, 2 for the 6 C 5 R.C.A. detector, amplifier and 3, 4, for the 6 K 7 super control amplifier pentode. Curves 1 and 3 are taken with correct grid resistors, while with 2 and 4, the grid was imperfectly earthed and may be described almost floating.

Again the negative slope of the screen grid valve characteristics when the screen voltage is higher than the plate voltage, has the effect of reversing the closed curves, as illustrated in Figs. 5 and 6, which were taken with the tetrode 46.

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COLORIMETRIC ESTIMATION OF IRON WITH RESACETOPHENONE-OXIME

SNELL[1] describes sixteen reagents for the colorimetric estimation of iron and of these a dozen are organic compounds. Since then several other organic reagents have been added to the list. Recently Howe and Mellon[2] investigated the iron-salicylaldoxime colour reaction spectrophotometrically and found that pH was a critical factor and, with solutions buffered with ammonium acetate, the colour obeys Beer's Law over a wide concentration range of iron.

Astin and Riley[3] drew attention to the expensiveness of salicylaldoxime as a reagent and in their investigations on the determination of copper, to cut down the cost, they adopted a procedure involving the production of the oxime *in situ* so that isolation became unnecessary. It must, however, be pointed out that salicylaldehyde itself is an expensive item. Further, Howe and Mellon (*loc. cit.*) found that dilute aqueous alcoholic solutions of this oxime (0·1 per cent.) were not quite stable. This adds to the cost of the reagent.

The present authors found that resacetophenone-oxime also gives a similar purple colour with ferric iron and the sensitivity was comparable with that of salicylaldoxime. Resacetophenone is neither costly nor difficult to prepare being obtained in very good yield from resorcinol, glacial acetic acid and anhydrous zinc chloride. This compound has also been introduced as a reagent for the detection of iron by Cooper.[4] The oxime (colourless crystals, m.p. 198-200° d.) is obtained easily by the usual method and is cheaper than salicylaldoxime. Resacetophenone-oxime is readily soluble in alcohol and is not precipitated by large dilution with water. Aqueous alcoholic solutions (0·5 per cent.) are quite stable for long periods. Control of pH is necessary with this reagent also. Buffering with ammonium acetate was found to give satisfactory results. Experiments carried out with Kletts' colorimeter and artificial illumination showed that the limits for the balancing method, with a final dilution of 25 ml. after developing colour, was 2·0 to 0·1 mg. of iron. Because of the powerful illumination, at the still lower concentrations of iron, the colour shades were too light for satisfactory matching.

The colour characteristics and the applicability of Beer's law could not be studied spectro-photometrically at present. This investigation will be taken up and the results published later on.

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October 6, 1945.

1. Snell, "Colorimetric Methods of Analysis," 1936, 1, 283. 2. Howe and Mellon, *Ind. Eng. Chem.*, (*Anal*). 1940, 448. 3. Astin and Riley, *J.C.S.*, 1933, 314. 4. Cooper, *Ind. Eng. Chem.* (*Anal*)., 1937, 9, 334; *of Annual Reports*, 1937, 487.

THE NUTRITIVE VALUE OF MILK AND CURDS

THE status of milk as the only food for infants carries with it the implication that it contains all the essential nutrients. Even for children, adolescents and adults, milk is almost an essential article of diet. An enormous amount of work has been done in Western countries to ensure the production and distribution of milk under hygienic conditions. Pasteurization is the process of choice for rendering the milk free of micro-organisms and at the same time retaining most of its nutritive value.[1] In India the conditions, however, do not permit strict control of the distributon of milk and as an alternative measure of safety every housewife boils the milk before it is used. This process causes destruction of some of the essential nutrients, such as vtamin A, C and carotene.[2] Unlike the Western countries the curds prepared by fermenting milk, forms an important constituent of most Indian dietaries. Yet the nutritive value of curds has formed the subject of few investigations. The studies in the bacteriology of milk have been undertaken to find out mainly the ways and means to prevent the growth of pathogenic organisms such as *Mycobacterium tuberculosis* and the organisms belonging to the enteric group.

According to Supplee,[3] the whey from the rennet curds is a rich source of vitamin B complex. It also contains, provitamins D and K in addition to minerals and hormones. Curds, therefore, would be a better source of nutritive material than whey on account of its additional protein and fat content. During the pro-

cess of curdling by fermentation the milk may be invaded by a variety of micro-organisms some of which may be pathogenic; but under controlled conditions it is a seat of various strains of streptococcus lactis, yeast and gram negative lactobacillus. Investigations of Najjar, Holt, Elvehjem and others have shown that such micro-organisms are able to synthesize some vitamins.[4] According to them such micro-organisms if found in the gastro-intestinal tract of animals, including human beings, would synthesize some vitamins[5,6,7] which could be utilized by the host in case of deficiency. It is, therefore, logical to believe that the micro-organisms responsible for curdling of milk would also synthesize, during their growth, some vitamins at the cost of other nutrients from milk. A probing investigation was, therefore, thought essential in order that the changes in the nutritive value of milk after curdling might receive a thorough study. The knowledge thus obtained would also be helpful in preparing curds of a high nutritive value.

As a preliminary measure the estimations of some members of vitamin B complex were undertaken. Curds was prepared by the usual household procedure. Samples of fresh whole milk were obtained from the local shop. The milk was boiled and cooled till it was only slightly warm. It was then inoculated with a very small quantity of preformed curds and left undisturbed for 24 hours at room temperature. By that time curds had formed. The sample of the milk as well as the curds from it were analysed for their vitamin contents by fluorimetric and colorimetric methods. The results are given in the following table.

TABLE I
Thiamine, Riboflavin and Nicotinic acid contents of Milk and Curds

Sample No.	Thiamine µg per gm.		Riboflavin µg per gm.		Nicotinic acid µg per gm.	
	Milk	Curds	Milk	Curds	Milk	Curds
1	..	..	0·79	1·39	0·63	0·30
2	..	..	0·69	0·69	0·67	0·38
3	..	..	0·69	1·32	0·59	0·25
4	..	..	0·86	1·22	0·63	0·26
5	..	..	0·90	1·15	1·75	1·00
6	..	..	0·95	1·15	2·50	1·00
7	0·40	0·52	..	..	2·37	0·69
8	0·43	0·52	..	..	2·25	0·63
9	0·24	0·27	0·59	0·79	0·88	0·50
10	0·21	0·27	0·73	0·86	0·88	0·38
11	0·31	0·37	0·63	0·89	0·88	0·38
12	0·30	0·37	0·59	0·79	0·81	0·44
13	0·30	0·32	..	..	1·00	0·38
14	0·29	0·37	..	..	1·13	0·50
15	0·32	0·37	..	..	1·00	0·61
16	0·31	0·32	..	..	0·89	0·50

The results are interesting inasmuch as the riboflavin content was found to increase and nicotinic acid to decrease due to fermentative changes. The changes in thiamine were not so marked. The results of these experiments show that it would be interesting to extend the study to the influence of fermentative curdling on other nutrients in milk such as proteins, fats and minerals. Moreover such data would be extremely useful if studies are carried out using individual micro-organisms for fermentation. Further work is in progress and will form the subject of detailed communications later on.

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October 6, 1945.

1. Kon, S. K., *Nature*, 1941, **148**, 607. 2. Deco, M., *Compt. Rend. Soc. de Biol.*, 1939, **130**, 819. 3. Supplee, G. C., *Industr. and Engin. Chem.*, 1940, **32**, 238. 4. Wegner, M. I., Booth, A. N., Elvehjem, C. A., and Hart, E. B., *Proc. Soc. Exptl. Biol. Med.*, 1940, **45**, 769. 5. Welch, A. D., and Wright, L. D., *J. Nutrition*, 1943, **25**, 555. 6. Najjar, V. A., and Holt, L. E., Jr., *J. Am. Med. Assoc.*, 1943, **123**, 683. 7. —, *Ibid.*, 1944, **126**, 357.

SOME ANALOGUES OF D.D.T.

A RECENT publication[1] by E. A. Prill, A. H. Hartzell and J. M. Arthur on the alkoxy analogues of D.D.T., necessitates the publication of the results which we have already obtained in the condensation of chloral with various aromatic substances.

1. Chloral condenses to give D.D.T. type of compounds with anisole (m.p. 96°), *o*-cresol methyl ether (m.p. 94-96°), *p*-cresol methyl ether (m.p. 160°), resorcinol dimethyl ether (m.p. indefinite, decomposes before melting), thymol (m.p. 201°), *p*-chloroanisole (m.p. 146°) and bromo-benzene (m.p. 146°). All the m.p. are with decomposition.
2. Chloral condenses to give $R\text{-}CHOHCCl_3$ type of compounds with *m*-cresol methyl ether (m.p. 110°), hydroquinone dimethyl ether (m.p. 166°) and β-naphthol (no m.p.).
3. Chloral condenses to give amorphous noncrystallisable substances with all phenols (except phenol and thymol), veratrol, thymol methyl ether, α-naphthol methyl ether, β-naphthol methyl ether and naphthalene.
4. Chloral did not condense with iodo benzene and *m*-dichloro benzene.
5. Bromal did not give D.D.T. type of compounds with any of the above substances. With alkoxy benzenes, however, bromal gives compounds of the type $R\text{-}CHOHCBr_3$.

A detailed description of these compounds along with their insecticidal properties will be published in due course.

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November 10, 1945.

1. *Science*, 1945, **101**, 464, No. 2627.

A NOTE ON THE ESSENTIAL OIL FROM GINGER SCRAPINGS

The gingers of commerce are chiefly obtained from India, China and Jamaica. Though ginger is cultivated in many parts of India, the best ginger is obtained from the Malabar Coast. In Travancore alone, about 25,000 acres are under ginger and the quantity exported is about 3,000 to 4,000 tons.

The rhizomes are submitted to an elaborate process of cleaning and bleaching before marketing in several grades like white ginger, rough unbleached, rough bleached, etc. In preparing the best quality ginger, the rhizomes are scraped to remove the outer skin. Large quantities of these scrapings accumulate and these are generally wasted These scrapings have been reported to give an essential oil.[1]

Rao, Sudborough and Watson[2] as well as Moudgill[3] have distilled the scrapings and reported the constants and yield but data about the distillation under reduced pressure and constituents are not available. The oil is now shown to resemble ginger oil since it contains camphene, β-phellandrene and Zingiberene, all of which are present in ginger oil.

Experimental

50 Lbs. of the air-dry scrapings were obtained fresh, from North Travancore and distilled in a copper still with water (hydrodistillation). The distillate gave a light yellow oil (yield 0·8 per cent. on air-dry material).

Physical and chemical constants of the oil are given in Table I.

TABLE I

	Author's Sample	Rao, Sudborough and Watson	Moudgill	Pure ginger oil
Yield	0·8% air dry	3·45 (on dry basis)	0·9% (air dry)	
Density (30° C.)	0·8905	0·8822 (at 15° C.)	0·8816	0·875—0·886
Ref. Index (30° C.)	1·4859	1·4988 (25° C.)	1·4862	1·4795—1·4855
(a)D	—5·2	—39·2	—9·85	—28 to 50° C.
Acid value	0·90	2·1	1	0—2
Ester value	6·10	7·7	10	0—15
Acetyl value	72·2	49·8	103	33·42

Distillation under reduced pressure.—60 c.c. of the oil were distilled under reduced pressure (8-10 mm.). The physical constants and other details of the fractions are given in Table II.

TABLE II

Fraction No.	Temperature	Weight in gm.	Density 30° C.	Refractive index	Rotation in 5 cm. tube
1	80– 90°C.	8·2	0·8670	1·4670	+25·72
2	90–100°C.	6·0	0·873	1·4700	+19·32
3	100–110°C.	2·20	0·8800	1·4750	+5 10
4	110–120°C.	2·40	0·8840	1·4756	+4·00
5	120–130°C.	4·8	0·8860	1·4825	+1·57
6	130–140°C.	6·8	0·8890	1·4910	+16·93

Fractions 1, 2 *and* 3.—These were mixed together and distilled at atmospheric pressure and separated into four fractions (Table III).

TABLE III

Fraction No.	Temperature °C.	Weight in gms.	Density 30° C.	Ref. index 30° C.
A	30—160	4·2	0·862	1·4640
B	160—165	3·6	0·864	1·4651
C	165—170	3·0	0·876	1·4660
D	170—175	2·1	0·883	1·4690

Fractions A and B were separately tested for camphene by conversion into isoborneol[4] by heating with glacial acetic acid and 50 per cent. of sulphuric acid and then converting the acetate by alcoholic potash. They gave isoborneol (m.p. 212° C.).

Fraction C, after another distillation, gave β-phellandrene-nitrate (m.p. 101-102° C.)[5] with sodium nitrite and glacial acetic acid.

Fraction D did not give any crystalline products.

Fractions 4 *and* 5 were treated for alcohols but none has been identified.

Fraction 6 contains Zingiberene. This fraction was distilled under reduced pressure (10 mm.) and the portion distilling over 128-132° C. (over 75 per cent.) gave the nitrosite (m.p. 97-98° C.) and hydrochloride (m.p. 168-169° C.).[6]

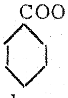
Further work is in progress.

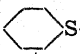
The author acknowledges his indebtedness to Dr. K. L. Moudgill, Director of Research, for his keen interest in this work.

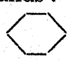
Central Research Institute,
Trivandrum, N. S. Varier.
November 9, 1945.

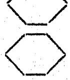
1 and 2. Rao, Sudborough and Watson, *Jourl. Ind. Inst. Sci.* 3. Moudgill, K. L., *J. Ind. Che. Soc.* 4, 5 and 6. Parry, "The Chemistry of Essential Oils and Artificial Perfumes". 3rd Edn. 2, pp. 40, 60 and 72.

CHEMOTHERAPY OF SOME ORGANO-MERCURY COMPOUNDS—THEIR ACTIVITY AGAINST STAPHYLOCOCCUS AUREUS

J. WALDO[1] prepared some organo-mercury compounds of the following type COOH  SHgR where R is an alkyl or aryl group, by reacting alkyl mercury halides with thio-salicylic acid. He found them to be very active against staphylococcus aureus; and in fact the sodium derivative of the ethyl compound is sold in the market under the trade name of "Merthiolet" (product of Lily & Co.).

With the idea that the presence of -N  S- group will add to the bactericidal property of the compound we prepared the following two series of compounds:

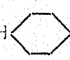
(*i*) AcHN  SHgR

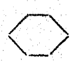
(*ii*) O_2N  SHgR

where R is an alkyl group. When mercurials of the type RHgX, where X is a halogen radical, reacts with a mercapto-acid HSR′, a double decomposition occurs,

$$RHgX + HSR' \rightarrow RHgSR' + HX.$$

We prepared our compounds by the same methods:

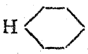
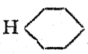
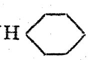
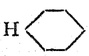
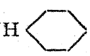
(*i*) AcNH  SH + RHgI → AcNH  SHgR + HI

(*ii*) O_2N  SH + RHgI → O_2N  SHgR + HI

Bacteriological Test.—The bactericidal tests of the organo-mercury compounds are carried out by agar cup method on staphylococcus aureus. 15 c.c. of nutrient agar are put in on each test tube, the tubes are then sterilised at 15 lbs. pressure for 30 minutes. Before testing, the sterilised agar tubes are melted and cooled to near about 45° C. The tubes are then charged with 0·1 c.c. of 24-hour culture of staphylococcus aureus and then poured into sterilised petri-dishes. They are allowed to harden and a hole was bored in the agar with a sterile cork-borer. The cup was then filled with drug solution. Since most of the drugs are not soluble in water, olive oil emulsion was adopted in every case. A control test was performed with olive oil and it was found to be inactive against the staphylococcus aureus. The petri-dishes were incubated for 24 hours and the zone of inhibition was clearly noted.

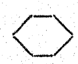
The serial dilution of each compound was tested and the maximum dilution which showed inhibition is shown in the following table.

TABLE I

Compound	M.P.	Maximum dilution which is active against staphylococcus aureus
1. AcNH  SHgMe	185°	1.00,000
2. AcNH  SHgEt	176°	1.000,000
3. AcNH  $SHgC_3H_7$	155°	over 1,000,000
4. AcNH  $SHgC_4H_9$	150°	over 2,000,00
5. AcNH  $SHgC_5H_{11}$	144°	100,000
6. AcNH  $SHgC_7$H15		10,000

Since the chemicals were not available the hexyl-compound could not be prepared.

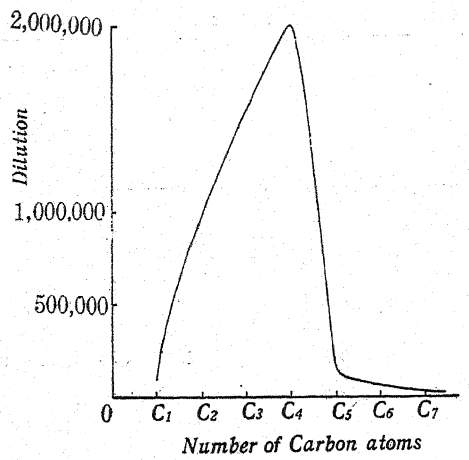
TABLE II

Compound	M.P.	Maximum dilution which is active against staphylococcus aureus
1. O_2N  SHgMe	130°C.	1,000,000
2. O_2N  SHgEt	124°	1,000,000
3. O_2N  $SHgC_3H_7$	90°	10,000
4. O_2N  $SHgC_4H_9$	65°	10,000
5. O_2N  $SHgC_5H_{11}$	60°	1,000
6. O_2N  $SHgC_7H_{15}$		nil

Since the chemicals were not available the hexyl-compound could not be prepared.

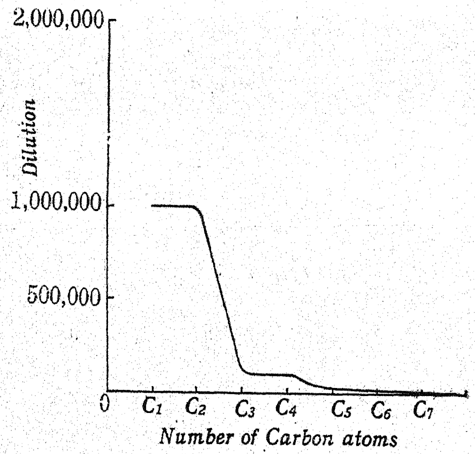
An interesting point may be observed from Table I that the activity of the compounds increases with the increase of the number of carbon atoms in the side chain, upto a certain number and then again falls. It is shown graphically in Graph No. 1.

In Table II it can be seen that the activity of the compounds decreases with the increase



GRAPH No. 1

of the number of carbon atoms in the side chain, which is shown graphically in Graph No. 2.



GRAPH No. 2

Our thanks are due to Prof. P. C. Guha and Dr. N. N. De, for their kind interest during the course of this investigation.

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Bangalore,
November 1945.

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AN INSTANCE OF GRAPES-POISONING

It is well known that meat, fish and milk are most important but vegetables, cereals and very occasionally fruits, may be responsible for cases of 'food-poisonings' to ensue. It is equally well known from statistics available that only a small percentage of food-poisoning (3·9 per cent.) cases comprise those of the fruits and vegetables origin. And it must be admitted that cases of microbial poisoning (metallic poisonings occasioned by erosion of the containers are reported to have taken place) in acid fruits and vegetables are relatively unknown. Yet one positive instance of grapes-poisoning had come under our observation and study.

During March 1943, two adults who had partaken a purchase of fresh Nasik grapes showed fairly severe signs of acute gastro-intestinal disturbances; they had only a passing suspicion on grapes, but on our request, however, they sent a sample of their fæces and the remaining supply of grapes to our laboratory for examination. The grapes on macroscopic examination looked very attractive indeed, being fresh and "lively", green-yellow in colour. Almost synchronously, a member on the staff of our College became a victim, presumably of grapes-poisoning. Being a biologist with some information on food-poisoning, he reported the case immediately and sent a bunch of grapes for examination and report thereon. This bunch appeared much the same as the other sample received before so much so that they should be regarded as collected from the same vineyard. All the three victims of poisoning had identical types of symptoms to complain, which principally consisted of intestinal pains and explosive evacuations of diarrhœic fæces one half to two hours after the consumption of the grapes.

The samples of fæces on naked eye examination appeared to be whitish to yellowish-green in colour and were more watery than normal. The fæces and the grapes were then cultured (grapes after treating them with a dilute solution of mercuric chloride as per the technique of Harrison and Barlow) on Endos, Czapek and Blood agar plates. Duplicate sets were made and one set was kept at the room temperature (27° C.), the other incubated at body temperature (37° C.). After the incubation, three organisms of likely ætiological relationship with the disease were picked up and subjected to detailed examination for establishing their identities. Two of them were Gram-negative and short bacteria and the third was an unusual looking yeast culture. The Gram-negative bacteria were easily identified as (1) *Escherichia coli communis* (significant in the report as they were persistently isolated from the grapes and not from the fæces); (2) *Pseudomonas æruginosa* (Bact. pyocyaneus). The yeast culture after some difficulty was spotted as a *Cryptococcus* variety (resembling closely *Cryptococcus plimmeri*, described by Guilliermond), an organism pathogenic to guinea-pigs on intraperitoneal inoculation.

Thus the rare instance of grapes-poisoning proved to be possibly a case of mixed infection of relatively acid-tolerant types of micro-organisms having no apparent relationship to each other: but there is no doubt whatsoever

about the pathogenic actions of the three species referred above.

J. V. BHAT.
MISS R. N. REPORTER.
F. FERNANDES.

Microbiology Department,
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Bombay,
September 25, 1945.

1. Bergey, D. H., *et al.*, *Manual of Determinative Bacteriology*, 1939. 2. Guilliermond, A., *The Yeasts.* Translation by F. W. Tanner, 1920. 3. Harrison, F. C., and Barlow, B., *Centr. Bakt. II Abt.*, 1907, **19**, 264–72.

ROLE OF MANGANESE IN THE FORMATION OF VITAMIN C AND CAROTENE IN PLANTS

VARIOUS factors have been reported in literature to affect vitamin C formation in plants. It is found to be favoured by potash fertilization[1] or, by application of calcium nitrate[2] but to be retarded by nitrogen fertilization.[3] Little evidence, however, has been adduced regarding the influence of manganese on vitamin C or carotene formation in plants. Hester[4] observed an increased formation of ascorbic acid in tomatoes grown on soil high in available manganese, but Lyon and Beeson[5] failed to find any appreciable change in vitamin C content of tomatoes grown in solution cultures under manganese treatment. On the other hand Rudra[6] noted in its presence an enhanced production of ascorbic acid by animal tissues—from glucose and by germinated seeds. Manganese, as has been pointed out by earlier workers, plays a vital role as a catalyst in the physiological processes of the plant, e.g., in photosynthesis and nitrogen assimilation,[7] in oxidising enzymes[8] and in various other aspects.[9] Its action as a catalyst has been stressed in the oxidation of organic matter.[10]

An investigation was carried out by the author on *Amaranthus gangeticus*, grown in pot-cultures with local soil low in available manganese. Below are presented the results (average of several replicates) obtained for the control and four treatments, A, B, C and D, of manganese, the amounts applied as $MnSO_4 4H_2O$ being 0·05, 0·1, 0·2 and 0·3 gms. respectively per pot (6 lbs.). The vitamin C estimations in the leaves were made by the method of Harris and Olliver,[11] carotene by that of Moore[12] and manganese according to Piper.[13]

From the results (*cf.* Table), the formation of carotene seems to have been uninfluenced by the treatment while that of vitamin C has been affected to various degrees by the added manganese, a significant point being that it is encouraged upto a certain concentration of added manganese beyond which additional concentrations become increasingly harmful. This action seems to run parallel with its action in promoting the plant-growth and is thus indicative of its overall influence on the metabolic activities of the plant. Note may also be made in this connection of the increasing absorption of manganese by the plant in direct relationship with the treatment. It may act directly as a coenzyme or activator of the enzymatic system responsible for the biosynthesis of vitamin C in plants from carbohydrates, or indirectly through its overall influence on the metabolic activities of the plant. Considerable further work is, therefore, needed before the mechanism through which the vitamin C formation occurs in the plant and the role played by manganese therein are elucidated.

Soil Treatment	Total green wt. yield in gm.	Manganese content of leaves in p.p.m.	% increase in the Mn content over control	Vitamin C content in mg. per 100 gm. of fresh material	% increase in vit. C content over the control	Caroten econtent in μ gm. of fresh material
Control	63·14	109·4	..	253·1	..	98·82
A	76·73	136·8	25·04	352·3	39·19	103·1
B	68·40	145·7	33·17	299·4	18·31	102·9
C	62·69	152·6	39·49	238·3	— 5·848	99·65
D	51·31	161·2	47·34	225·0	—11·10	101·0

The author wishes to express his indebtedness to Prof. V. Subrahmanyan for his keen interest and kind encouragement in the work as also for valuable discussions.

Department of Biochemistry,
Indian Institute of Science,
Bangalore, Y. B. RANGNEKAR.
November 3, 1945.

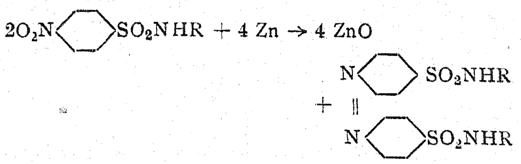
1. Hester, J. B., *Amer. Fert.*, Nov. 1941, **93.** 2. Hausen, S. von., *Biochem. Z.*, 1936, **288**, 378. 3. Jones, W. W., *et al.*, *Science.*, 1944, **99**, 103. 4. Hester, J. B., *Science*, 1941, **93**, 401. 5. Lyon, C B., and Beeson, K. C., *J. Amer. Soc. Agron.*, 1943, **35**, 166. 6. Rudra, M. N., *Nature*, **1944**, **153**, 743. 7. McHargue, J S., *J. Amer. Chem. Soc.*, 1922, **44**, 1592. 8. Bertrand, G., *Compt. rend.*, 1905, **141**, 1255. 9. Brenchley, W. E., *Biol. Rev.*, 1943, **18**, 159. 10. Iyer, H., Rajagopalan and Subrahmanyan, *Proc. Ind. Acad. Sci.*, 1935, **11B**, 108. 11. Harris, L. J., and Olliver, M., *Biochem. J.*, 1942, **36**, 155. 12. Moore, L. A., *Ind. Eng. Chem. A. E.*, 1940 **12**, 726. 13. Piper, C. S., "Soil and Plant Analysis," (Univ. of Adelaide), 1942.

STUDIES IN THE SYNTHESIS OF SOME SUBSTITUTED BENZENESULPHONAMIDES. PART III.—A SIMPLE NEW METHOD OF SYNTHESIS OF SOME N-SUBSTITUTED AZOBENZENE 4, 4′-DISULPHONAMIDES

MANY unsymmetrical azobenzene sulphonamides have been made by diazotising a suitable amine and coupling it with a second amino or phenolic compound.[1] But few symmetrical azobenzene-4, 4′-disulphonamides have so far been reported and these have been made by the sulphonation of azobenzene followed by conversion to the corresponding sulphochloride and treating the latter with a suitable amine to form substituted amides.[2–4].

It is surprising that no attempts have been made so far to directly reduce a nitrobenzene-sulphonamide to the corresponding azo-bis compound in the manner of the preparation of azobenzene from nitrobenzene.

The present paper describes the successful application of this simple method to the production, in almost theoretical yields, of eight such azo-bis compounds using the corresponding nitrobenzenesulphonamides referred to in Part II of this series.[5]



The substances analysed correctly for nitrogen by the modified Kjeldahl method of Part II.[5]

As, however, the nitrogen content of the azo and the corresponding hydrazo compounds is very nearly the same, the reduction equivalents of the compounds using stannous chloride were determined, thereby obtaining a positive confirmation of the azo structure of these compounds, the reduction equivalents of the hydrazo being double those of the corresponding azo compounds. For this purpose, a weighed quantity of the azo compound was boiled with an excess of standard stannous chloride solution in an atmosphere of carbon dioxide under reflux during about an hour till the azo compound completely dissolved. The excess of stannous chloride was titrated against standard iodine solution. In all cases the equivalents approximated to the theoretical value for the azo compounds showing the remarkable stability of the azo compounds to further reduction in spite of the excess of zinc used.

The accompanying table summarises the analytical data of the eight azo-bis compounds synthesised in this work.

Azo-derivative	Yield %	M.P. in °C.	Percentage of Nitrogen		Stannous Chloride Equivalent	
			Calcd.	Found	Calcd.	Found
$[=N.C_6H_4.SO_2NH_2]_2$ [2–4,6–7]	95	307	16·4	16·28	85	86
$[=N.C_6H_4.SO_2NHCH_3]_2$	87	248–49	15·21	15·19	92	94
$[=N.C_6H_4.SO_2NHC_2H_5]_2$	85	230·5	14·13	13·85	99	111
$[=N.C_6H_4.SO_2NHC_{10}H_7(-\alpha)]_2$	85	267	9·45	8·91	148	160
$[=N.C_6H_4.SO_2NHC_{10}H_7(-\beta)]_2$	96	265·5	9·45	9·14	148	156
$\left[=N.C_6H_4.SO_2N\begin{smallmatrix}CH_3\\C_6H_5\end{smallmatrix}\right]_2$	93	214–15	10·76	10·22	130	116
$\left[=N.C_6H_4.SO_2N\begin{smallmatrix}C_2H_5\\C_6H_5\end{smallmatrix}\right]_2$	97	212·5	10·21	9·86	137	146
$[=N.C_6H_4{\cdot}SO_2NH{\cdot}C_6H_4{\cdot}SO_2NH_2]_2^4$	80	312	12·9	2·2	162	161

The general procedure adopted was to treat the nitro-compound, suspended in sufficient alcohol, with three atomic proportions of powdered zinc and an excess of 30 per cent. aqueous sodium hydroxide solution. The mixture was refluxed for about five hours. The product separated as an insoluble sodium salt. The whole reaction mixture was evaporated to dryness, neutralised with 7 N sulphuric acid and filtered. The precipitate was well washed with water and then alcohol and in some cases crystallised from the latter, yielding orange-coloured crystalline substances.

My thanks are due to Mr. P. Ramaswami Ayyar for valuable suggestions and guidance, and to Dr. P. C. Guha for kind interest.

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Bangalore, (MISS) R. J. IRANI.
December 4, 1945.

1. Northey, *Chem. Rev.*, 1940. **27**, 129–38. 2. Limpricht, *Ber.*, 1881, **14**, 1356. 3. Laar, *Ibid.*, 1881, **14**, 1928. 4. Huang-Minlon, *et al.*, *J. Chinese Chem. Soc.*, 1942, **9**, 57-60; *Chem. Abs.*, 1944, **38**, 1216. 5. *Curr. Sci.*, 1945, **14**, 126. 6. Scudi, *J. Am. Chem. Soc.*, 1937, **59**, 1480. 7. Seikel, *Ibid.*, 1940, **62**, 1214.

ETHER ACETIC AS A FUMIGANT

During the last twenty years much attention has been paid to the use of the fumigants for the control of insect-pests of the stored products. Some of these fumigants have proved to be very promising. But in India little work has been done to study the use of fumigants. After a series of trials it was found that among the fumigants tried, "ether acetic" was a promising fumigant. The results of my small-scale experiments are presented here so that the interested workers may try it on large scale and confirm my view of its use on a commercial basis.

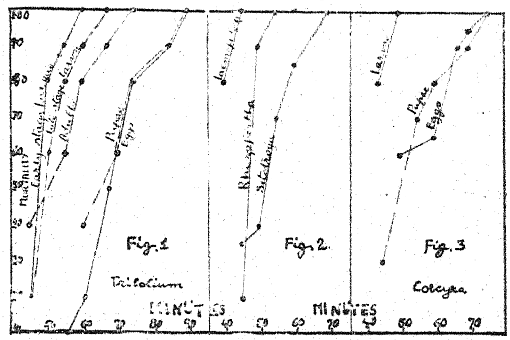
'Ether acetic' has not been used so far as a fumigant. It contains less than 80 per cent. pure ethyl acetate, and about 18 per cent. ethyl ether. Neifert *et al.*,[1] and Back and Cotton[2] have experimented with ethyl acetate, either as such, or in a mixture form with carbon tetrachloride but the ether acetic of commerce has not been experimented upon. Ether acetic is a colourless, clear, watery fluid, with a characteristic pungent smell. It is acid to litmus, miscible in all proportion with alcohol, chloroform, oil and ether. It is soluble in water, being more soluble at lower temperatures than at high temperatures. It is non-poisonous to human beings, and does not stain metal, wood or textile fabrics.

The experiments with ether acetic have been carried out on a laboratory scale. The experimental insects were taken in a small petri-dish and covered with cotton-wool. The dish was buried in a tank (glass) of dried fruits. Near the top of the tank was hung, from its lid, a flat dish containing ether acetic. No special precautions were taken to make the lid air-tight. For every observation a separate set was taken. In those cases in which the mortality was below 100 per cent. the experiments were not repeated. When the mortalities reached 100 per cent., the experiments were repeated at least six times, with different varieties of fruits. A record of temperature and humidity of the atmosphere was retained throughout the period of experiments. The following insects were used in the experiments: *Tribolium castaneum* Hbst (eggs, early larvæ, late larvæ, pupæ and adults), *Rhizopertha domenica* Fab. (adults) *Lœmophlœus* (adults), *Sitotroga cerealella* Oliv. (early larvæ), and *Corcyra cephalonica* Staint. (eggs, larvæ and pupæ). Adequate controls were run side by side. The dose of the fumigant remained constant, while the period of exposure was varied. The dried fruits used for the experiments were raisins dates, figs, walnuts and cashew-nuts.

Tribolium.—All the eggs were killed within 90 minutes' exposure. The early stage larvæ were killed in much shorter period, *viz.*, 100 per cent. mortalities in 60 minutes. The late stage larvæ appear to be more resistant than the early stage larvæ but less resistant than the eggs (100 per cent. mortality in 67 minutes). The pupæ are more or less as resistant as the eggs (100 per cent. mortality in 90 minutes). The adults are less resistant in comparison either to the eggs or to the pupæ, but more resistant than the larvæ (100 per cent. mortality in 75 minutes).

Rhizopertha adults succumb to the action of the fumigant within 55 minutes. The fumigant is equally effective against *Lœmophlœus* adults (100 per cent. mortality in 45 minutes), *Sitotroga larvæ* (100 per cent. mortality in 70 minutes), and *Corcyra* (the time taken for 100 per cent. mortality in the case of eggs 75 minutes, larvæ 50 minutes and pupæ 75 minutes).

The mortalities which take place after an exposure for shorter periods than mentioned above are shown in the graph.



Ether acetic is an effective fumigant for controlling insect-pests of dried fruits. A dose of ½ oz. per 6 cubic feet of space is sufficient to achieve 100 per cent. mortality in case of *Tribolium castaneum*, *Rhizopertha domenica*, *Lœmophlœus*, *Sitotroga cerealella* and *Corcyra cephalonica*.

The work was carried out in the laboratory of the Imperial Entomologist, New Delhi.

Agricultural Research
Laboratories, Gwalior, R. Rakshpal.
October 15, 1945.

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2. Back and Cotton, *J. Econ. Ent.*, 1924, **17**, 663.

STUDIES IN THE SYNTHESIS OF SOME SUBSTITUTED BENZENESULPHONAMIDES PART. IV—SYNTHESIS OF TWO NEW N¹-SUBSTITUTED *p*-ACETAMINO-BENZENESULPHONAMIDES AND THE CORRESPONDING FREE *p*-AMINO COMPOUNDS

In connection with the preparation of the azo compounds of Part III,[1] a review of the final reduction products, namely, the corresponding aminobenzenesulphonamides, revealed that *p*-aminobenzenesulphon-, methyl and ethyl-anilides and the corresponding N^4-acetyl derivatives have not been synthesised so far. Their synthesis was, therefore, undertaken.

The method employed consisted of the condensation of *p*-acetaminobenzenesulphochloride (1 mole.) with methyl- and ethyl-anilines (each 2 moles) respectively, in alcoholic solution. The acetamino compounds were isolated and subsequently hydrolysed by boiling with 10 per cent. aqueous hydrochloric acid to the free amino compounds in the usual manner.

The equivalents of the two amino compounds were determined by diazotisation in acid solution with a standard solution of sodium nitrite checked against a standard solution of pure sulphanilic acid.

Compound	Yield %	M.P. in °C.	Percentage of Nitrogen		Diazotisation Equivalent	
			Calcd.	Found	Calcd.	Found
$CH_3CONH.\ C_6H_4.\ SO_2N\langle^{CH_3}_{C_6H_5}$	70	153–54	9·20	9·11	..	..
$CH_3CO\ NH.\ C_6H_4.\ SO_2N\langle^{C_2H_5}_{C_6H_5}$	69	125–26	8·80	8·77	..	..
$H_2N.\ C_6H_4.\ SO_2N\langle^{CH_3}_{C_6H_5}$	79	140	10·69	10·63	262	264
$H_2N.\ C_6H_4.\ SO_2N\langle^{C_2H_5}_{C_6H_5}$	82	132–33	10·14	10·13	276	280

The analytical data are summarised above.

My thanks are due to Mr. P. Ramaswami Ayyar for guidance and to Dr. P. C. Guha for kind interest.

Dept. of Pure & Applied Chemistry,
Indian Institute of Science,
Bangalore, (MISS) R. J. IRANI.
December 4, 1945.

1. *Curr. Sci., loe. cit.*

STACKBURN DISEASE OF RICE IN BENGAL

IN June 1945, a small laboratory experiment was started with a view to determining the relative abundance of pathogenic fungi borne on paddy seed. Forty seeds, some normal in appearance and others discoloured, were sown in Roux tubes on cotton soaked in distilled water. The tubes were all plugged and sterilised before use. In all, 21 seeds failed to germinate. All these eventually became covered with mycelium. In some cases, this mycelium was white, and on examination was found to bear, singly, on the tips of conidiophores not readily distinguishable from the mycelium, almost hyaline spores, rather resembling in shape those of *Alternaria*, club-shaped, septate, with an extremely long, septate "tail", the cells of the spore proper being constricted at the septa, with the second or third cell from the base often considerably larger than the rest. The fungus will be referred to for the moment as the "white mould". The distribution of fungi amongst the 21 non-viable seeds was as follows:

Helminthosporium oryzæ Breda de Haan—6.
Curvularia lunata—4.
White mould fungus—7.
Common moulds—4.

Out of the 19 seedlings which germinated (and which, naturally, eventually sickened through unfavourable conditions for development in the test-tubes) ten bore minute black sclerotia on the coleoptile, first leaf and roots. Four of these seedlings were removed and placed in a moist chamber. All developed the mycelium of the white mould fungus, with typical caudate conidia. Pure cultures were obtained and readily formed both sclerotia and spores on potato dextrose agar.

Germination tests were carried out on seeds of six varieties of paddy in petri-dishes. Five hundred seeds of each variety were used. Table I indicates the number of cases of seedlings showing each of the three fungi.

TABLE I

Incidence of Helminthosporium oryzæ, Curvularia *and white mould in* 500 *seeds of each of six varieties of paddy.*

Variety	*H. oryzæ*	*C. lunata*	White mould
Latisail	31	45	42
Kumargorh	62	12	28
Asra	20	12	19
Patnai 23	42	5	12
Nigersail	12	25	45
Du Lar	29	15	12

The fungus bore an unmistakable resemblance to that figured by Tullis (1936) and tentatively identified as *Trichoconis caudata* (App. and Str.) Clements, the sclerotium-forming fungus which causes seedling blight and stackburn disease (Tisdale, 1922) of rice in the United States of America. This fungus was originally described as *Piricularia caudata* with the conidial measurements $9\text{-}12 \times 36\text{-}45\ \mu$ and the filiform seta $35\text{-}45\ \mu$ long. The measurements of spores of our white mould, including the appendage, taken from infected material in a moist chamber was $12{\cdot}6 \times 146{\cdot}2$ $(8{\cdot}5\text{-}15{\cdot}7 \times 103{\cdot}2\text{-}172{\cdot}7)\ \mu$, the difference in length being due to the extreme length of the

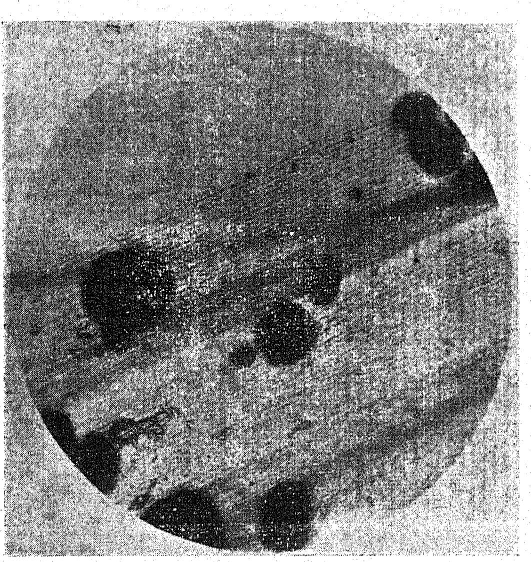

FIG. 1

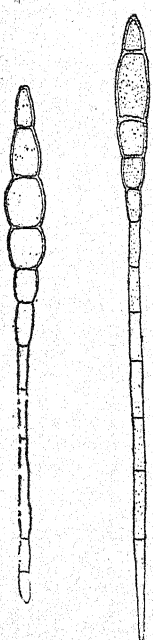

FIG. 2

appendage (Fig. 1). The sclerotia (Fig. 2), which were black, almost spherical, and more or less imbedded within the host tissue, and which had a somewhat reticulated wall, measured 124 (52-195) μ. With some reservation (in view of the difference in spore size) we follow Tullis (*l.c.*) in regarding this fungus as *Trichoconis caudata* (App. and Str.) Clements. It was found on diseased leaves in the field quite frequently before carrying out the experiments recorded above, but was regarded as insignificant until it was seen to be similar to that causing stackburn disease in the United States of America. The damage caused by the disease in Bengal has yet to be determined and the description of the various symptoms of the disease on the plant and the seed is reserved for a fuller study.

G. WATTS-PADWICK.
D. GANGULY.
Bengal Agricultural Institute,
Tejgaon P.O.,
Dacca (Bengal),
October 22, 1945.

1. Tisdale, W. H., 1922, "Seedling blight and stackburn of rice and the hotwater seed treatment," *U.S.D.A. Bull.*, No. 1116. 2. Tullis, E. C., 1936, "Fungi isolated from discoloured Rice Kernels," *U.S.D.A. Tech. Bull*, No. 540.

A STUDY OF THE FACTORS RESPONSIBLE FOR THE COLOURS OF SOILS OF C.P. AND BERAR.

THE colour of the black tropical soils has been the subject of diverse views, and various theories have been advanced to explain their characteristic black colour. The earliest one of these sought to attribute the colour to titaniferrous magnetite (Annet[1]), but has been shown to be restricted in its scope, as this component is not of universal occurrence in all black soils. Humus by itself cannot be considered as the black colour component as its amount in tropical conditions is never pronounced.

The black soils of C.P. and Berar, studied by the author, are known to have been derived from different types and systems of rocks like the trap and the various mixed sandstones, derived from the Vindhyan and the Gondavana systems. The nature of the parent rock, which varies widely in the chemical composition such as the Ca and Mg content, cannot, therefore, explain the formation of black colour. More recently workers[3,5] in India have propounded the view that the colour is due to the humus in a fully saturated condition or to the clay-humus complex. Full experimental proof in support of these views is not, however, available.

For arriving at any definite conclusion it is necessary to isolate the esential colour constituent and eliminate the subsidiary factors by analytical methods as far as possible. To begin with, therefore, the mechanical fractions of the soils were separated without drastic pre-treatment and the colour of each fraction recorded by a method based on Whittles.[6] It was found that the clay fraction alone was black in colour while the other fractions, *viz.*, the silt and the sand had ashy-grey and brown tinges respectively. All the black soils studied had a clay percentage of over 50 per cent. As such it is safe to conclude that this fraction alone contributes to the black colour of these soils.

The effect of the removal of humus on the colour of the soils was studied by treating the soils and their clays with H_2O_2. The colour change after the treatment was recorded by the disc technique. It was found that there was no material change in colour by this treatment showing that appreciable amounts of

organic matter are not removed by oxidising with H_2O_2. Actual determinations showed that not more than 33 per cent. of the organic matter could be decomposed by this treatment.

Sodium hydroxide solution as prescribed by Arnold and Page[2] was found to be more effective in this respect, as much as 86 per cent. of organic matter being removed. In case of the clays of these soils all the organic matter was removed by the treatment. The black soils and their clays treated with this solution were found to lose their characteristic colour, the residues being of a grey or brown colour, while the red and the yellow soils were not affected by the treatment.

It is thus amply clear from the above experimental evidence, that the clay in association with the humus as clay-humus complex is responsible for the colour of black soils. These soils have alkaline reaction, a high content of exchangeable bases (mostly Ca), which condition is known to be favourable for the formation of the clay-humus complex.

The influence of the SiO_2/R_2O_3 molar ratios on the colour of soils has been studied by previous workers, but a comparison of the ratio (see table) of black soils with that of soils of

Soils	SiO_2/R_2O_3 molar ratio in clay	Total Fe_2O_3 (HCl soluble)	Hematitic free Fe_2O_3	Limonitic free F_2O_3
Black soils—				
1. Black cotton soil	3·00	9·37	3·28	2·30
2. Kabar soil	2·57	10·80	2·33	4·14
3. Kheri ,,	2·79	7·23	2·09	1·27
4. Kanhar ,,	2·50	6·74	1·17	1·99
5. Mariar ,,	..	5·84	1·77	0·98
Red soils—				
6. Hill top soil, Nagpur	1·99	25·6	18·6	4·92
7. Wardi soil (very light red)	2·49	6·53	2·52	2·53
8. Bhata soil	..	24·4	16·16	8·02
Yellow soils—				
9. Dorsa soil	2·10	6·25	0·69	3·23
10. Sehar soil	2·21	4·26	0·76	2·24
11. Matasi soil	2·33	3·11	0·55	2·13

other colours showed that there is hardly any variation in this respect from soil to soil to account for such colour variations.

The investigation on the black colour of soils is not complete without reference to the other colouring constituents, chief of which are the oxides and the hydroxides of iron. The effect of removal of these by Harada's[4] method was, therefore, studied in the various soils. It was found that after the removal of the oxides and the hydroxides of iron, the residues from black soils were still black whereas the yellow and the red soils completely lost their colours, the residues being light sandy or not coloured. The colour of the red and the yellow soils is thus principally due to these iron compounds.

Actual estimations of free iron oxides and hydroxides show that the black soils also contain appreciable amounts of these constituents. These amounts are comparable with those of other soils, with the exception of two soils of a distinctly lateritic nature.

The figures of analysis in the table show that the red soils are rich in hematitic iron oxide while the yellow soils contain most of the free iron oxide in the limonitic form. It is interesting to note in this connection that the yellow soils occur in regions where the agricultural practice keeps the soils submerged for a good period of the year indicating that a process of slow hydration of iron oxide accompanies prolonged contact with water.

In finding the factors responsible for the colours of soils it, therefore, appears necessary to take into consideration the effects of various colouring constituents, in order to find out the preponderating component which is likely to mask the colours of other minor factors, and thus give the final colour to the soil.

The author is thankful to Mr. R. C. Shrivastava, I/C Agricultural Chemist to the Government of C.P. & Berar, and Dr. K. G. Joshi, Provincial Biochemist, Compost Scheme, for the interest shown by them in the work.

Agricultural Res. Institute,
Nagpur, R. H. JOSHI.
October 15, 1945.

1. Annet, *Memoirs of the Dept. of Agr.*, 1920. 2. Arnold and Page, *Journ. Agr. Sc.*, 1930, 460. 3. Desai, A. D., *Bulletin, Dept. of Agr.*, No. 10, H.E.H. the Nizam's Govt. 4. Harada, M., *Journ. Am. Ch. Soc. Abstracts*, 1937, **31**, 2559-60. 5. Venkatramiah and Raghavendrachar, *Proc. Assoc. Ec. Biol.*, **5**. 6. Whittles, *Journ. of Agr. Sc.*, 1931, **21**.

RACIAL SIGNIFICANCE OF PATELLAR GROOVE

THE racial differentiation of the Indian and the European femora depends mainly on the increased range and frequency of the movements of the knee joint in the former as compared to the latter.[4] The constant and forceful impact of soft structures and the tendons around the knee joint leaves permanent features, of not inconsiderable anthropological interest, which are invariably identifiable, and often measurable in the dry bones. Thus a large number of variations in the lower end of femora have come to be recognised in Indians[1,2,3] and some other races, modern and ancient.[4,5] To these variations may be added that in the depth of the patellar groove of the femur.

The depth of the posterior end of the patellar groove in front of the intercondylar notch was measured in 200 femora from Punjabis and expressed as a fraction of the 'true' length of the femur.

It was found that in 62 per cent. of bones examined the groove was deeper than 1/45 and in 3·5 per cent. shallower than 1/60 of the length of the femur. In Europeans[4] the corresponding figures are 3 per cent. and 7 per cent. respectively. This shows that in a very large percentage of European femora (97 per cent. and 93 per cent.) the patellar groove is

neither too deep (1/45) nor too shallow (1/60); while in 62 per cent. of Indian bones the groove was deeper than 1/45 and in only 3·5 per cent. it was shallower than 1/60 of the length of the bone.

Considering the distribution of the femora according to the depth of the groove it was found that in 87 per cent. the groove was deeper than 1/52 and in 13 per cent. shallower than 1/51 of the length of the bone. Corresponding figures for Irish[4] are 50 per cent. and 50 per cent. for English[4] 30 per cent. and 70 per cent. respectively.

The conclusion from the above results appears to be obvious. In the majority of Indian femora the patellar groove is deeper than it is in Europeans. The increased depth is attributable to more frequent rubbing movements of the patella, on the patellar groove, in the much more active knee joint of an Indian.

Department of Anatomy,
Dow Medical College,
Hyderabad (Sind), M. A. SHAH.
October 9, 1945.

1. Siddiqui, M. A. H., *J. Anat.*, 1934, **68**, 331. 2. Shah M. A., *Ibid*, 1942, **77**, 110. 3. Shah, M. A., *Cur. Sci.*, (in Press) 1945, 4. Martin, C. P., *J. Anat.* 1932, **66**, 371. 5. Siddiqui, M. A. H., *Ibid.*, 1936, **70**, 410.

A NOTE ON THE CULTURE OF *OSPHRONEMUS GORAMI* LACEPEDE IN CEMENT CISTERNS*

MASONRY cisterns, usually regarded as unsuitable for Gourami culture, have been found suitable provided adequate weedage is offered.

A pair of adult Gourami, measuring 10" and 10½", was introduced in June into a cement tank in the Municipal Park at Rajahmundry. The tank cuts a cross-shape internally and covers an area of 40 square feet with 3½ feet depth. The sides are vertical and cemented and the bottom is evenly plastered. The water is let in through a pipe arrangement at the bottom. A 3-inch layer of fine sand was spread at the bottom to plant *Hydrilla* in clusters.

The fish were found to feed on the tender foliage of *Hydrilla*. To keep them in prime condition the supplemental diet of ground-nut oil-cake was also given. In the last week of September the fish were restless and the female was suspected to guard a particular spot amidst the vegetation, while the male was vigilant some two feet away from the female. After the fry emerged, a search was made for the nest near the suspected spot. The trailing shoots and the foliage of *Hydrilla* were knitted nicely to form a thick cover with an opening facing the centre of the cistern. The nest was 6 inches above the ground. It was vertically drawn out and had no distinct form.

Fingerlings numbering 30, of the size of 1" to 1½" were seen frequently coming to the surface of water. Gourami can thrive and breed in masonry tanks of fair depth, if any suitable material like *Hydrilla* for nest-building is furnished.

Inland Fisheries,
Nellore, V. D. SPURGEON.
July 13, 1945.

* Published with the permission of Director of Industries and Commerce, Madras.

SYMBIOSIS IN SPITTLE INSECT* *PTYELUS NEBULOSUS* FABR.

THE present communicaiton deals with the symbiosis of *Ptyelus nebulosus* Fabr. belonging to the family *Cercopidæ*. The two tumours of Bacteriotomes are on either side of the abdomen and as usual differ in size. The one nearer to the skin is coloured ochre to brown. The other which covers the former tumour as seen from inside is reddish in colour. The intensity of the colour of the tumour is more in the nymphal stages than in the adult stages of the insect. While dissecting it was observed that the brown tumour is a very delicate one for it disintegrates into small bits when kept for sometime in tapwater, but this is not the case with the red tumour.

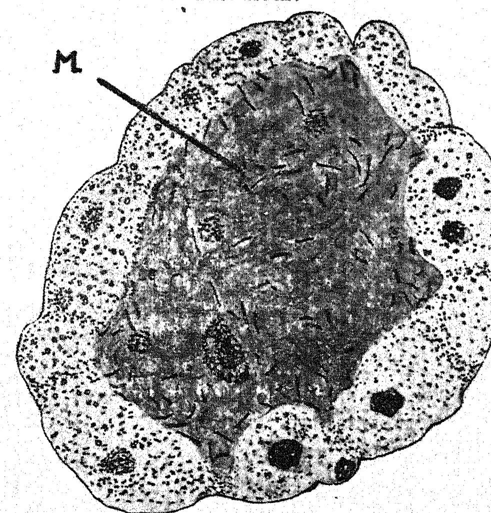

FIG. 1. M. Bacteria.

Fig. 1 stained in Heidenhain's hæmatoxylin (without counter-stain) represents a cross-section of the red tumour. Syncetium is full of bacteria, its circumferance is surrounded by cells not infected by bacteria but the cell

FIG. 2. M. Bacteria

margin is very indistinct. Fig. 2 represents a smear from the red tumour, the smear was fixed with Bouin's fluid and subsequently stained with Giemsa as mentioned in my previous

* Identification of the insect has yet to be confirmed.

communication (*Current Science*, Vol. 14, R.P. 210-11, August 1945). The bacteria are not uniform in size as has been noticed by several workers on Symbiosis. These bacteria stain red with Giemsa. According to the previous work done in this Laboratory these bacteria are real Symbiots and are probably responsible for the pigment production. This hypothesis can be incidentally conformed by the observation that during the nymphal stages the red bacteriotome is more intense in colour than in the adult stage.

With regard to the brown tumour it may be pointed out that it is pressed between the chitinous skin and the enveloping red tumour.

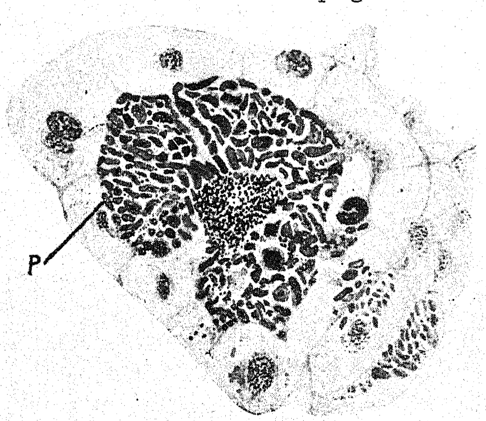

FIG. 3. P. Unknown Cell-inclusion

Fig. 3 represents cross-section of the brown tumour stained in Heidenhain's hæmatoxylin. The cell-inclusions are not clearly defined like many others recorded in the literature on Symbiosis. Buchner and his school look upon these cell-inclusions as fungi of unknown classification. However, a smear from such a tumour when stained with Giemsa imparts the cell-inclusions the plasmatic blue colour,

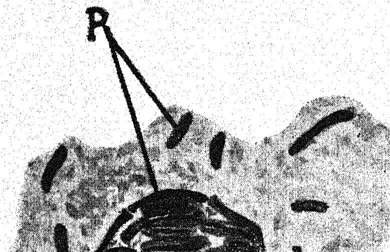

FIG. 4. P. Unknown Cell-inclusion.

which is distinct from the red nuclear stain given to bacteria. Fig. 4 represents such a smear. The cell-inclusions are very near in shape to those figured by Buchner for *Aphrophora alni* (Fig. 9 c, p. 112, Z. f. *Morphologie und Œkologie*, 1925).

The work was done in the laboratory of Dr. S. Mahdihassan and my thanks are due to him and to Professor B. K. Das.

Osmania Medical College,
Hyderabad (Dn.),
October 18, 1945.

MOHANBABU NAIDU.

PALÆOLITHIC SITES IN THE NELLORE DISTRICT

IN *Current Science* for February 1940 I had the privilege of making a preliminary statement about Palæolithic Sites in the Nellore District. I wish to report a site recently found which is of special interest because it seems to offer a geological clue to the age of stone-age tools in this part of India. The Madras trunk road, south of milestone 149, crosses an artificial drainage channel which serves to divert rain water into a tank east of the railway line which here parallels the highway at about a half-mile distance. The area between road and railway is reserved forest, a sparse jungle of thorny shrubs. From the channel the surface of the ground slopes very gently upward to the south toward a low ridge of laterite. Northward from the channel the surface is nearly level with, in places, drainage toward the channel. Material removed from the channel is heaped on either side. The excavation cuts across a deposit of stiff red clay which varies in thickness from a few inches to as much as eight feet. Beneath the clay is a thin layer of laterite overlying greatly decomposed granitic rock. In this channel we have found 140 stone-age implements of which the greater part are listed in Memoir No. 68 of the Archæological Survey of India.* A considerable number have been found *in situ* in the red clay at depths of 2 or 3 feet. But recently I found a fine quartz implement imbedded in this clay at no less than seven feet below the surface of the surrounding jungle floor. A geologist competent to study the terraine and discover the source of the clay and estimate its rate of deposit might have a valuable clue to the antiquity of stone-age man in this area. I have seen no place where an equal opportunity is offered and hope someone will be interested to look into it.

The implement is a *coup de poing* made by crude primary flaking on a quartz cobble stone. It is 11·3 cm. long, 8·3 cm. wide and 4·8 cm. thick. It has a heavy pebble butt and might be classed as Acheulean in type.

FRANK P. MANLEY.

Ramapuram,
Nellore Dist.,
October 17, 1945.

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* *The Manley Collection of Stone Age Tools*, by A. Aiyappan and Frank P. Manley.

ON THE OCCURRENCE OF A GYNOPHORE IN *DRABA* SP. FROM KASHMIR, WITH REMARKS ON THE PHYLOGENY OF THE GYNOPHORE IN THE CRUCIFERÆ

THE presence of a gynophere in *Draba* sp. is not peculiar to the Cruciferæ, but a prolongation of the axis at the base of the ovary is recorded by Schulz (1919, 1935) in about a dozen different tribes of this family, *viz.*, Brassiceæ, Cremolobeæ, Romanschulzieæ, Streptantheæ, Sisymbrieæ, Mathioleæ, Arabideæ, Lunarieæ, Stanleyeæ, Hesperideæ, etc. A short or a long gynophore is described in *Brassica elongata, Diplotaxis harra, D. tenuifolia* (Schulz, 1919, p. 105), *Cremolobus, Lunaria, Macropodium, Stanleya, Thelypodium* and *Warea* (Schulz, 1936, p. 241). Although a gynophore is already known in Drabeæ, so far as the author is aware, it is not previously recorded in *Draba muralis* L. or *D. nemoralis* L. Dr. Stewart told me that our plant is not a normal healthy specimen but it is diseased. The present record is, therefore, an abnormal case and the abnormality is probably a result of hypertrophy caused by the disease.


FIG. 1


FIG. 2

Fig. 1 is a half-natural size photograph of a floral branch of *Draba* sp., which according to accompanying notes on the sheet, was collected by J. R. Drummond on June 30 in 1902 from the Kashmir Valley; it was found growing in a flax field near Shopyon at an altitude of 6,000 feet. This plant, together with several other specimens, was sent to India after an incomplete identification at Kew and bears the number 13956 Ex. Herb. Kew. It was made available to me through the courtesy of Dr. R. R. Stewart, who received for identification several incompletely determined specimens from Drummond's Kashmir collections from Principal J. C. Luthra of the Punjab Agricultural College, Lyallpur, to whom this specimen was returned after study. On an enquiry kindly made at my request by Dr. Stewart from Kew the above identity of the plant was confirmed.

In Fig. 1, especially near the apical parts of the inflorescence axes, there are seen several flower-buds which show distinct gynophores; however, they are not so well marked in fruits. The flower-buds and fruits on dissection showed a structure typical of the genus *Draba*, and although on account of the absence of leaves and for want of exact information regarding the habit of the plant it is not possible to identify the specimen with more certainty, it shows a great resemblance to *Draba muralis* Linn. or *D. nemoralis* L. This identification was kindly confirmed by Dr. Stewart and our figured specimen is a branch of either of the two species bearing abnormal flowers.

In a natural size photograph of a part of the specimen (Fig. 2) the nature of the raceme is clearly seen; and several fruits (marked with arrows) are seen to possess at bases of the siliquas small stalks which are undoubtedly of the nature of gynophores.

It is interesting to note that a short or a long gynophore is recorded in as many as 12 out of the 19 tribes into which this family is divided. In the more primitive tribes of the family, *e.g.*, Stanleyeæ, Romanschulzieæ, Streptantheæ, Cremolobeæ, etc., the gynophore is well developed and occurs more commonly, but in the intermediate forms, *viz.*, Brassiceæ, Lunariæ, etc., a short gynophore is found in a few genera. In Sisymbrieæ, Mathioleæ, Arabideæ, Hesperideæ, etc., which are the higher tribes of the family the gynophore gets very much reduced in size and completely disappears in most cases. In Drabeæ, which is believed to be one of the most highly developed tribes of the Cruciferæ, a very short gynophore may be present in primitive genera, but it is so far previously not recorded in the genus *Draba*.

The present abnormal occurrence of a gynophore in *Draba*, which, according to Schulz (1936, p. 266), is one of the most highly evolved genera of the Cruciferæ, seems to throw important light on the phylogeny of the gynophore in this family. Although abnomalities, as a class, are generally treacherous guides to affinities, very often they provide interesting evidence regarding the phylogeny of certain organs and throw important light on their phylogenetical significance.

From the above facts regarding the occurrence of a gynophore in the Cruciferæ it may

be concluded that this organ is a primitive structure found in the lower tribes of the family, but in the more specialized forms, where it is either altogether absent or occurs only as a very short stalk at the base of the ovary, it has undergone suppression. The occurrence of a gynophore as an abnormality in one of the most highly evolved genera of the family is evidently a reversion to ancestral character found normally in the primitive members of the Cruciferæ; this reversion has probably taken place as a result of hypertrophy caused by the disease.

Further support for the conclusion that absence of the gynophore is an advanced character is found in the Capparidaceæ, a family with well-acknowledged affinities towards the Cruciferæ and one regarded as more akin to ancestral forms from which both the families have arisen. In some species of Cleome, notably *C. monophylla* and *C. Stocksiana*, the ovary is either sessile or it may bear a very small stalk at its base. In *Cleome viscosa* the ovary, as a rule, is sessile, but occasionally one comes across a rudimentary stalk at its base. In the primitive tribes of the Capparidaceæ the gynophore is not only well developed but is of a very common occurrence.

In the end I wish to record my most grateful thanks to Professor B. Sahni, SC.D., F.R.S., and my friend, Dr. V. Puri, D.SC., of the Meerut College, for helpful suggestions and expert advice. I am also thankful to Dr. R. R. Stewart, Principal, Gordon College, Rawalpindi, who went through this note and kindly confirmed the identification of the specimen.

Dept. of Botany & Geology,
University of Lucknow, G. S. PURI.
October 22, 1945.

* Schulz, O. E., *Cruciferæ in Engler's Pflanzenreich*, **1919, 5,** 105, and *Cruciferæ in Engler-Prantl Naturliche Pflanzen Familen.*" 1936, Band **17B,** 244–266.

D. D. T. AND CATTLE TICKS

IN view of the encouraging results reported to have been obtained with D.D.T. in various spheres of entomological research, the author, at the suggestion of Major Ch. Williamson, Animal Husbandry Commissioner with the Government of India, carried out some preliminary trials at the Imperial Veterinary Research Institute, Mukteswar, to determine the effect of this drug on cattle ticks in India.

Emulsions of D.D.T. were prepared in turpentine and in kerosene oil, using liquid soap as an emulsifying agent in each case. The concentrations employed were 0·1, 0·2, 0·5 and 1·0 per cent. Cattle heavily infested with ticks (*Boophilus australis* Fuller) were sprayed in batches with different concentrations of these emulsions. It was found that (*i*) D.D.T., in emulsion with turpentine at concentrations of 0·2 and 0·5 per cent., destroyed ticks in their larval, nymphal and male adult stages. The percentage of ticks destroyed varied from 80 to 90 per cent. on sprayed cattle. Engorged female ticks did not seem to be affected, except that they failed to oviposit when incubated at 22° C. or 37° C. after each spraying; (*ii*) a single spray of D.D.T., in emulsion with kerosene oil and liquid soap at a concentration of 0·5 per cent., destroyed all stages of ticks within a period of a few minutes. In this case cent. per cent. tick mortality was observed. Turpentine or kerosene oil in emulsion with liquid soap when sprayed without the D.D.T., have practically no tickicidal value.

Experiments showed that, in the case of ticks, D.D.T. acted as a stomach poison and not as a contact poison or a repellent. The drug is non-poisonous to human beings and livestock.

As a point of practical utility, it may be mentioned that D.D.T. emulsion can be used in the form of a hand-dressing, thereby eliminating the cost and complications involved in cattle-dips and sprays.

The writer is indebted to Major Williamson for his occasional suggestions during the progress of these experiments.

Imperial Veterinary Research
Institute, Mukteswar, B. N. SONI.
October 18, 1945.

IMPORTANCE OF YELLOW CHANG-SHAN AND ITS PLAN FOR MASS PRODUCTION

THE term 'Yellow Chang-Shan' (*Dichroa febrifuga* Lour.) is Chinese classics and for thousands of years this plant has been the sole remedy for malaria. Owing to negligence very few Chinese medical men have ever adopted its use. Quinine from overseas has been decreasing in quantity on account of war and Chinese scientists have now come to give their special attention to this particular plant.

'Yellow Chang-Shan' is in reality the true variety of 'Chi-ku Chang-Shan' meaning 'Chicken bone Chang-Shan' in the 'Pen-Tsao', the well-known Chinese medical book.

This plant is adopted to shady place where soil is rich in humus. It grows well in wooded valleys above sea-level of from 1,000 to 1,800 metres. So Golden-Buddha Mountain of Nan-Chuen Hsien, Szechwen Province, is the ideal place for growing this plant.

The medical property of this plant is in its roots but its stems and leaves are also used by country people to cure malaria.

This plant is reproduced asexually but seeding process is now also under experimentation.

For mass production of this medical plant, the Ministry of Forestry and Agriculture and the Rear Service Corps agree to take the whole responsibility.

The plan for the production of this plant comes under two main divisions: plant-breeding and four-year plantation. When these come to completion this plant drug will suffice for the use of all who have malarial attack in this country.

To execute this plan 'The Golden-Buddha Mountain Chang-Shan Experimental Station', established by the Ministry of Forestry and Agriculture, has been assigned the special responsibility. MOSES S. D. SWEN.

The Golden-Buddha Mountain
Chang-Shan Experimental Station,
The Ministry of Forestry and
Agriculture, China.

REVIEWS

Radium Therapy—Its Physical Aspects. By C. W. Wilson. (Chapman and Hall, London), 1945. Pp. 224. Price 18 *sh*.

Of the many special branches of modern Medicine none is better built on a foundation of scientifically established facts than the radiation therapy. This has been accomplished by those few physicists who have been guiding and co-operating with the radiologists in this speciality. Dr. Edward Chamberlain, a leading Professor of Radiology of Philadelphia, recognises this fact when he says: "Physicists have not only supplied us with answers to our questions and apparatus to our needs, often they have had to show us what we wanted, what our needs really were." And Dr. Wilson's book furnishes another illustration of this close and fruitful co-operation between the physicist and the physician in the domain of radium therapy.

If radium therapy developed more slowly than did roentgen therapy it is not only because radium was very expensive and difficult to obtain but also the problems of practical dosimetry and the creation of increasingly flexible and effective apparatus have been more difficult of solution with the tremendously more penetrating gamma-rays from radium. The crucial subject in this domain which still needs further study and greater clarification is the measurement and control of gamma-ray dose and its distribution in the irradiated field. Dr. Wilson has done well to clearly stress this point and to indicate the need for further investigation.

The book is on the whole a well-balanced account of the fundamentals of radiation physics and their application to the solution of problems of treatment with radium and as such will be found most useful by curietherapists. The important question of protection from gamma-rays of both the patients and the staff is thoroughly discussed in the light of the recommendations made in 1943 by the British X-ray and Radium Protection Committee.

However, the usefulness of the book would have been decidedly greater had Dr. Wilson gone more critically and in greater detail into the question of radon service and the requirements of an up-to-date radon laboratory. There is no doubt as to the general agreement at present that the future of radium in therapy is more towards interstitial and contact application and less in the form of bombs for telecurietherapy. Supervoltage apparatus are already available that are capable of producing X-rays of one to two million volt energy. These units are safer, enormously more powerful and are very much less expensive than any existing radium bomb and patients suitable for telecurietherapy are already being advantageously treated with such apparatus. It is, therefore, not unreasonable to assume that the future use of radium is certain to be for contact application in which form it has some well-established advantages over any other form of radiation therapy. Radon service is definitely superior to the direct utilisation of radium salts in any medical centre of importance which aims at making the most of its resources for extensive radium therapy.

R. Naidu.

Colorimetric Analysis. By Noel L. Allport. (Chapman and Hall, Ltd., London), 1945. Pp. xii + 452. Price 32 *sh*.

The ceaseless search of the analyst for simpler and more rapid methods of analysis has resulted in a widespread adoption of physical methods such as colorimetric, conductometric and potentiometric methods. The popularity of colorimetric methods can be attributed to the improvement of apparatus of measuring the absorption of light, and colorimetric methods have been developed for practically every element, radical and physiologically active compound. There is a large volume of literature devoted to the application of colorimetric methods of analysis in every field of scientific research.

Unlike the monumental work of F. D. Snell and C. T. Snell, the volume under review does not attempt to give a theoretical discussion of the methods or a description of the instruments employed for the determinations. The author's aim has been to offer a practical and concise handbook on colorimetric analysis. Only those methods which are known to be reliable and of which the author has first-hand knowledge as a research chemist in the *British Drug House, Ltd.*, have been included in the book. Special attention has been given to the application of colorimetry to the examination of natural and manufactured products. The limitations of each method are indicated, thereby enabling the analyst to choose the one which satisfies his requirements. When the colour tests are of general utility, the descriptions have been supplemented by detailed procedures for their more important applications. The approach is critical throughout.

For convenience, the book has been divided into five sections. The first deals with the colorimetric determination of some important metallic elements chosen for their biological or industrial significance. The platinum group of metals have been omitted as gravimetric methods are more reliable. Altogether 25 metals have been dealt with and 357 references to original literature have been included.

The second section refers to the methods for the estimation of acid radicals. Most of the methods are widely used in biochemical investigations and their application demands elaborate care. As many as 15 radicals have

been dealt with including tartarates, salicylates, oxalates, lactates, p-hydroxy benzoic acid and its derivatives. 121 References are included in this section.

Substances of clinical and biochemical importance with special reference to biological fluids such as urine, blood and spinal fluids, are covered by the third section. The 30 fluids to which attention has been given have been chosen for their importance and their representative character. 304 References are included in this section.

Section IV deals with the methods for alkaloids, hormones and vitamins. 12 Important alkaloids and 3 hormones are included. Colorimetric evaluation of hormones has not, so far, led to any important results and the author has rightly included only 3 of them. Among the vitamins, vitamin A and its precursor carotene, vitamins of the B group, and vitamin E are dealt with exhaustively. There are 184 references in this section.

The last section includes methods of determination of miscellaneous substances whose selection has been based mainly in consideration of their general interest, and also with a view to make up any possible omissions in the earlier sections. Some 20 substances have been treated under this head and there are 109 references to original literature.

The volume would have been self-contained and its usefulness enhanced, if a chapter on instruments had been included. Colorimetric analysis is tending towards instrumentation. The accuracy of the estimations which has been stated to be ± 5 per cent., has been greatly improved by the use of filter photometers and spectro-photometers. Nessler's tubes are only relics of the past and objective methods of measurement by the use of photoelectric cells have largely eliminated personal errors and fatigue factors incidental to visual observations. The author has chosen to keep out nephelometric methods from consideration. While it is true that nephelometry is not colorimetry, the two methods have a family affinity. Both are based on the measurement of light that reach the observation point after passing through test solutions. The measuring equipment is more or less similar in both cases, and many of the nephelometric methods are of great value and convenience. The volume is well written and documented. There are very few books of this type in the English language, and it should prove useful and handy in all analytical and research laboratories.

A. K.
B. N. S.

Manufacture of Lead and Slate Pencils, with Special Reference to India. By N. N. Godbole. ("*Leader*" Press, Allahabad), 1945 Pp. 40. Price Rs. 4.

It is difficult to understand the purpose of this publication. In his Foreword, which has been written because the author feels that "it is customary for an author to write a foreword", it is stated that the contents were published in a popular magazine nearly three decades ago. A study of the booklet makes one feel that they should have been left where they were. There is little in the book that is of practical value to a prospective pencil manufacturer. The author's advice is to import refined graphite "rather than take up the responsibility of purifying the Indian graphite", to import wood, and with these to manufacture pencils with the machinery that may be fabricated in India. In view of this advice, one should not expect the author to suggest processes for refining graphite or for treating the large quantities of second grade wood available in India to render them suitable for pencil manufacture. The only reference to the purification of graphite, which is casually mentioned, is "a simple process in which water is largely employed and on which it floats though specifically heavier". It is stated that in America "graphite purified by the air-blowing method is used". Apart from these illuminating references, there are no suggestions of practical value with regard to the purification of graphite. Regarding softening of wood, the author makes a passing reference to softening in Japan "by a process of heating". Clay of the right kind is said to be available in plenty in India. But one looks in vain for a definition of the characteristics which renders a clay suitable for pencil manufacture.

The publication is mostly padded with personal anecdotes of the author's ramblings in the forest regions of India in quest of pencil woods, which have been described as "both sensational and romantic" and which sometimes have "shaken the life out" of the author. There are several references to the author's opinions regarding forest managemnt in various areas. These anecdotes may be quite amusing but are, by no means, beneficial to the reader. The four pages of the leaflet on "Indian Woods for Pencil Making", recently issued by the Forest Research Institute, give more information of value than the bulk of the book under review which deals with the author's cursory survey of Indian forests.

The omissions in the book are too many to be dealt with in a review. The book covers but 40 pages. The price is too high for a book which at best may be only of historical interest.

A. K.
B. N. S.

Root Disease Fungi. By S. D. Garrett, M.A., D.I.C. "Annales Cryptogamici et Phytopathologici," Vol. 1, 1944. (Waltham, Mass., U.S.A., The Chronica Botanica Co., Calcutta: Macmillan & Co., Ltd.). Pp. xv + 177. \$ 4.50.

This is the first of the publications under the series "Annales Cryptogamici et Phytopathologici", edited by Frans Verdoorn, and forms a notable contribution to the study of the epidemology of root disease fungi, detailing methods of control. The book is divided into fifteen

chapters with suitable subclassifications and subject and author indices. The author of the work, Mr. S. D. Garrett, who is an acknowledged authority on the subject, reviews our present knowledge of the root disease fungi in an elegant manner as to arouse further interest in the subject in all those interested in plant pathology.

The profound influence exercised by environmental factors on the parasitism of soil-borne fungi, as first pointed out by the Wisconsin school of investigators under Prof. L. R. Jones, has become an established fact. The saprophytic microflora of the soil-inhabiting fungi, differentiated by Waksman and others into "soil inhabitants" and "soil invaders", is shown to play an important part in the control of the root diseases. The fungi of the soil inhabitant type, might, according to their nature, spread external or internal to the host. In the former case the disease usually spreads by means of rhizomorphs, the extent of the spread of the disease being determined by the "food base". In those cases where the spread of the disease is internal, as in tracheomycoses, the spread of infection is brought about after the disintegration of the parasitised tissues.

In Chapters 4 to 7, the various soil conditions that influence the spread of the disease are reviewed. These exert direct influence on the growth and spread of the fungi in those cases where the mycelium is external, and indirect in those fungi which are internal within the host by affecting its metabolism. The soil temperature, for instance, might not only determine the intensity of infection, but also the type of infection within the host. The other factors such as, humidity, texture of the soil and others which also take part in influencing the severity of the disease are discussed.

The perennation of the root parasitising fungi within the soil over long periods as active saprophytes on decaying matters, or surviving within the invaded tissue saprophytically by the formation of sclerotia, etc., and their importance in the control of the disease are finely dealt with. The various scientific methods of control of root diseases are explicitly presented in the last seven chapters. The crop rotation, which is the oldest and most efficacious method known, use of healthy sets and seeds for propagation purposes along with other sanitation methods, are discussed in detail. The problems concerning root disease fungi of plantations in virgin areas as expatiated by Napper and others, control of root infections by isolating the infected plants by trenching and other special methods of root disease control by amelioration of soil temperature, etc., are bound to be of great interest to plant pathologists. The book is very well produced, and may be heartily recommended to all those workers interested in the study of soil-borne fungi.

M. J. T.

Village Industrialisation. By Sir M. Visvesvaraya. (A.I.M.O. Brochure No. 3, Bombay) 1945. Pp. 33. Price Re. 1-4-0.

Plans for an all-out drive for the industrialisation and properly balanced rehabilitation of the country, both agriculturally and industrially, are all very thoughtfully drawn up and almost to the last detail with samples of tabular forms for stock-taking, investigations, etc. Here are some excerpts. "The fact should be brought uncompromisingly to the cognisance of our rural population that they as a community have been left weak and inefficient because there is no tradition or organisation in local areas to enable the people to work in combination or co-operation and to put forth disciplined labour or observe regular hours of work. By observing regular hours of daily toil, whatever be the vocation, by adhering to business hours fixed for the beginning and end of the day's labour, and by constant attention to self-education and promoting the working capacity of head and brain, the purchasing power of every village will grow and the homes of even the very poor will begin to glow with happiness and good cheer. . . . No rural family or individual should be without some subsidiary occupation to employ its or her spare hours. Cottage industries like home gardening, poultry keeping, spinning and hand-weaving, bee-keeping, mat making, and also breeding of sheep or pigs, etc., are within the grasp of every village resident, even the very poorest. With a little enterprise, numerous similar occupations can be created . . . As the rural population is not generally used to development work of any kind, special measures will be necessary, according to the conditions of each unit area, to induce the population to adopt and work the scheme . . . Unless people in each locality give up unprogressive habits and begin to think for themselves and increase their knowledge, skill and income, they will have no future."

Sir Mokshagundam appeals to the co-operation of all the intelligent and progressive elements of the population to plan and execute and improve by studying the results, on the lines suggested in this pamphlet, an organised movement for making the people industry-minded.

The reviewer is not a pessimist, but believes that an even more radical movement is necessary for making the people realise the evils of idle-leisure, and over-indulgence in coarse enjoyments such as in cinema theatres or in listening to endless music programmes on the radio, etc. These entertainments have their place but one cannot help remarking that they are making detrimental inroads into the lives of many rural and urban communities and are tending to wean them away from even the few traditionally practised useful hobbies they were hitherto deriving pleasure from. People have almost stopped to think for themselves, as everything is thought out for them over the radio and the press. The ennobling pleasures to be derived from useful hobbies, social service, study circles, etc., are belittled by the obviously more intense pleasures that can be more easily had, and at so very little cost!

We do hope Sir M. Visvesvaraya's sage counsels will be taken up in earnest by many local communities. Several practical suggestions for the selection and adoption of small-scale industries are included.

M. A. G. Rau.

Scope of Chemical Industry in India. By H. G. Biswas, M.Sc. (The Bengal Chemical and Pharmaceutical Works, Ltd., Calcutta), 1945. Pp. 44. Price Re. 1-4-0.

The author has in this monograph surveyed rather succinctly and largely in the light of his experiences, the present and future prospects of the chemical industries in this country. The inorganic and organic industries are dealt with separately, and under the subsections of (*a*) mineral acids, (*b*) salts and alkalis and (*c*) metals in the former, and in the latter as (*a*) acids, alkaloids, sugars and essential oils of vegetable origin, (*b*) fermentation industry, (*c*) coal-tar distillation products and allied industries and (*d*) synthetic organic chemicals of aliphatic group of the industries dependent upon them.

The chemical industry occupies a key position in the economy of every country, and its scope can be truly said to be unlimited because of the number of varieties it already comprise and the possibilities for fresh developments with progressive research, both in the pure and applied sciences. All of this is intimately bound with a sound knowledge of chemical engineering design and the facilities to fabricate the required equipments in this country. Mr. Biswas has however not touched on this aspect of the problem. Within the limitations he has set himself, he has reviewed the present production and the possible demands in the country for various chemical products and has emphasised those that may be regarded as urgent. It is needless to single out any of his suggestions for special mention. Quite naturally this author from Bengal has laid great stress on the utilisation of the coal resources of the country, and he has rightly also drawn the reader's attention to the great scope for fermentation industries.

This informative review with its exhortations to the reader will be found to be a useful matter for study and application.

M. A. G. RAU.

Disposal of War Surplus Stores and Ordnance Factories. By N. D. Sahukar. (A.I.M.O. Monograph No. 8, Bombay), 1945. Pp. 19. Price Re. 1-0-0.

Mr. Sahukar reviews a live problem of the day. All these surplus materials are, in the main, tax-payers' property, and it behoves that the disposal of these surpluses must be carried out on a planned basis, involving the least loss in cash to the tax-payer, the minimum of disturbance to the normal level of trades and industries, and the greatest benefit to the community as a whole.

The several Government enactments in U.K., U.S.A., and India, in order to achieve their disposal successfully, are surveyed and compared, and the imperative need for co-opting unofficial public men from trade and commerce and of technical personnel, is strongly urged. The author rightly points out that sufficient consideration has not been given by the government for the utilisation of some of the stores by educational institutions. There is bound to be many an item of stores, and particularly those of a scientific nature, which could well be utilised by such institutions. As far as possible government might donate such stores as a gift to them. If for any reason, it is considered that a free gift of such stores could not be made, the first option for their purchase, and at a special reduced price, could and must be given to these educational institutions. No better way of utilising surplus stores could be found than this. After all, educational institutions which can use surplus stores are very few in the country, and it is the government's duty to consider their claims over surplus stores in preference to the claims by other public bodies or Provincial and State governments.

The utilisation of ordnance factories for fruitful purposes is another matter of great importance. Many of them are first rate chemical industries, with several valuable equipments of multiple use, acquired at priority rates and pressed into service. A co-ordinated policy of reconstruction and reorientation of the output from these factories for meeting various civilian needs is a matter of primary concern, and should also be properly undertaken in co-operation with non-official public and technical personnel.

This pamphlet forcibly points out the need for a greater realisation of the various possibilities for utilising these surpluses to the greatest benefit of the nation.

M. A. G. RAU.

The Directiveness of Organic Activities. By E. S. Russell, O.B.E., D.Sc., F.L.S. (Cambridge University Press.) Pp. 196. 8*sh.* 6*d.* net.

The biologist, whether he takes to routine teaching or does intensive research, hardly finds any time to examine or review at frequent intervals the enormous data that is accruing in the various biological fields of thought. In giving food for thought from this angle, the reviewer considers that Dr. Russell's little book is brilliantly and authoritatively written. The author, with very apt examples, mostly Zoological than Botanical, takes the reader into a vastly intriguing field of what appears to be speculative thinking but which, as a matter of fact, is a logical theme supporting his conclusion that the mechanistic outlook must be mistaken, and that the teleological character of biological events must be accepted. Directiveness, or purposiveness, of different biological activity in the maintenance and restoration of structural and functional norms; in the satisfaction of metabolic needs; in the relation of goals to biological ends have been superbly presented with choice examples from the animal and plant kingdoms.

One cannot more aptly summarise this book than in the author's own words, "the mechanistic conception of the living organism being inadequate and restrictive, it is necessary to replace it by a more realistic conception, which shall take account of the fundamental or irreducible characteristics of living things,

those, namely, which are shown by no inorganic system, and without which no living organism is conceivable, characteristics therefore, which cannot have arisen during the course of organic evolution, for life of any degree presupposes them".

Thus, the philosophical implications presented in the book are likely to have strong supporters for and against and whatever side one might take there would be no stinting of praise to the author on the excellent examples chosen for a forceful exposition of his viewpoint.

T. S. SADASIVAN.

A Laboratory Handbook of Organic Qualitative Analysis and Separations. By V. S. Kulkarni. (Dastane Brothers' Home Service, 456, Raviwar Peth, Poona 5), 1945. Pp. 40. Re. 0-15-0.

The text presents material for college students of B.A. and B.Sc. classes for their guidance in organic qualitative analysis and separations. The first 16 pages introduce the student to a simple scheme for identification of simple organic compounds. Pages from 16 to 28 present a list of commonly occurring organic substances, their formulæ, melting-point or boiling-point, and in some cases, their derivatives. Fairly complete and accurate directions for the preparation of derivatives of common organic substances are given in pages from 28 to 37. The suggested methods enable the student to work successfully without constant assistance of the teacher. The rest of the pages contain a scheme for the separation of simple organic mixtures.

In the choice of substances and the general reactions given, the author has obviously in view, the reduced syllabus given for practical course for B.Sc. chemistry during war-time. Nevertheless, the reactions given and the methods suggested are fairly comprehensive and will serve the needs of the college students of B.A. and B.Sc. classes. The booklet on the whole provides a fairly well balanced introductory course in organic qualitative analysis for the college students. Further, textbook writing industry in this country has to make much headway. Books of the type under review show a happy augury and deserve encouragement.

M. S. MUTHANNA.

The Grasses of Burma. By D. Rhind. (Baptist Mission Press, Calcutta), 1945. Pp. 99. Rs. 5 or 7*sh*. 6*d*.

The work is a compilation by the author of available information found scattered in Government bulletins, forest publications and various other published and unpublished records. The compilation is meant to serve the purpose of a guide-book to grasses of Burma rather than of an exhaustive work of reference. The list of species recorded has been compiled by examination of specimens that had been preserved in the herbarium of the Mandalay Agricultural College, Burma, and some of the important herbariums in India. In listing the grasses, the bamboos in which Burma abounds and which comprise the major part of the flora of the country, have also been included. Descriptive notes follow the lesser known species of grasses of Burma but no descriptions accompany the better known ones and those previously described in readily accessible floras. This perhaps accounts for the small size of the publication. The importance of the present publication lies in having brought together information on grasses of Burma that were previously scattered and were inaccessible. It thus provides a handy source of referencee to workers on grasses. However, it is to be hoped that a more exhaustive work on the grasses of Burma, including a description of those collected but yet undescribed species would be forthcoming in the future.

A glossary and a list of fungi found on grasses in Burma form useful additions at the end.

L. S. S. KUMAR.

Sixth Annual Report, 1944—*The Tuberculosis Association of India.* (Published by the Tuberculosis Association in India, New Delhi.)

This Report consists of an introductory section dealing with the object of the Association followed by the annual report of the activities carried on by the Association, statement of accounts and several appendices dealing mainly with summaries of the reports of the Provincial and State Tuberculosis Associations.

As in the previous few years, the work of the Association during 1944 has been carried on under difficult war conditions. However, the quality and quantity of the work has been maintained at a satisfactory level. During the year under report there has been a further increase in the tuberculosis institutions in India; eight clinics, four sanatoria and two hospitals have been opened. One clinic and one sanatorium are under construction and proposals for the opening of two more clinics and three hospitals are under consideration. Information received from Administrations and States, as a result of enquiry, show that very useful work has been carried on by a majority of them, such as starting of sanatoria, building of clinics and special wards, hospitals, etc., while some States are awaiting the end of the war for active antituberculosis work. Due to the war, it had not been possible to appoint a full-time Medical Commissioner; but the Association has been fortunate in securing the services of Dr. P. V. Benjamin, who devoted a considerable portion of his time to the affairs of the Association and visited several centres to tender expert advice. One great difficulty that is being encountered is the death of trained workers and adequately qualified specialists. This is being partially met by holding post-graduate refresher courses and training health visitors, but for various reasons these courses had to be limited. The T.D.D. courses instituted by the Madras Government have been exceedingly popular. The Mysore Government has recently introduced a T.D.D. course and

most probably Calcutta and Delhi will follow soon. The full development of the Publicity and Propaganda Section, whose value is generally acknowledged, has been greatly hampered on account of the war, but the activities are carried on by means of pamphlets, charts and other useful materials. The Indian *Medical Gazette* has been of the greatest service to the Association, by publishing special Tuberculosis Numbers for the past seven years, but it is felt that the time has arrived when the Association should have a journal of its own.

During the year under report the Lady Linlithgow Sanatorium has further consolidated its position. The New Delhi Tuberculosis Clinics have continued to play important role in the prevention, diagnosis and treatment of tuberculosis and also by arranging home visits and contact examinations, training postgraduate students, health visitors and nurses and continuing the scheme of organised home treatment. A summary of reports of the Provincial and State Tuberculosis Associations is given in Appendix VIII, and a perusal of the same shows that uniform progress has been maintained by them in antituberculosis campaign and there has been further stabilisation and co-ordination of the work of the various institutions.

N. N. D.

India and International Economic Policies. (All-India Manufacturers' Organisation, Bombay), 1944. Pp. 97. Price Rs. 2-8-0.

This interesting brochure contains a statement of the views of the All-India Manufacturers' Organisation on the Agenda of the International Business Conference held in November 1944 at Rye, New York.

In the introductory pages the need for a new conception of India in the international world is pointed out and the basic assumption underlying the views of the A.I.M.O. is explained, *viz.*, the establishment of responsible National Government for the whole country. There are nine chapters and they are devoted to the consideration of provisional items included in the Agenda for the Business Conference, *viz.*, maintenance of private enterprise, commercial policy of nations, international currency problems, protection of international investments, industrialisation of new areas, shipping, aviation and world supplies of materials.

The national point of view is emphasised throughout, pointing out the need for intensive industrialisation so as to provide full employment and for treating India as an equal and independent unit by herself, participating freely in any international agreement relating to trade, industrial policy, shipping, aviation or currency arrangements. International cooperation in the disposal of raw materials for the rehabilitation of war-devastated countries and the establishment of a stabilised currency are advocated as necessary for the establishment of a better basis for international economic relations in the world. The urgent need for the liquidation of Sterling Balances is also pointed out. Several chapters contain, at the end, a summary of the views and this is very helpful to the reader.

The defence of private enterprise in an age, wherein economic forces appear to be swinging to the other end, cannot be accepted in total. Making a reference to American experience during war-time, it is urged that the evils of private enterprise may not exceed its good points. They advocate the maintenance of private enterprise in the initiation and operation of industries, trade and commerce and services including transport by air, sea or land. Many may not agree with the authors on this point. There are such statements elsewhere in the book which set the reader thinking about the correct economic policy for the country.

The get-up of the book is very attractive. Taking into consideration the intentions of A.I.M.O. in publishing their books and pamphlets, the price for this publication must be considered high.

The book may be read with profit by all those interested in the economic advancement of India.

B. R. S. R.

A Text-Book of Heat. By G. R. Noakes, (Macmillan and Co., Ltd., London), 1945. Pp. viii + 469. Price 10*s.* 6*d.*

In spite of the large number of text-books of heat now available, this new text by the author of the well-known books on Electricity and Magnetism and Light forms a welcome addition to the literature. The same up-to-dateness of outlook and treatment and attention to practical and everyday applications that were noticed in the same author's two previous books are noteworthy even in the present volume. Mr. Noakes proves himself to be a very good teacher both by the choice of topics and the method of handling them. In the present book the principles which guided the design of apparatus and the limits of accuracy obtainable are prominently dealt with. The ground covered seems to be ample for the B.Sc. Pass standard of our Universities, and the large number of problems provides ample opportunity for the student to make himself thorough with the subject. As compared with other text-books this volume is characterised by descriptions of most modern work which cannot fail to produce in the student the conviction that the subject is a live and growing one. The treatment of the dimensions of thermal quantities and the sections on meteorology are very useful additions to the usual run of subjects. The arrangement of material, particularly in calorimetry, is somewhat unusual and mixed up, and from the present writer's point of view, the frequent insistence on the difference in the various thermometric scales rather than on their approximation to one absolute scale may lead to greater confusion than to clarity. Some topics like the description of the Callendar & Griffiths' bridge, the derivation of van der Waals' equation and the

proof of Cornot's theorem will gain in clearness if the present treatment is somewhat amplified. The printing shows a number of instances of dropped letters, reminding us of the war-time production of the book. The reference to Fig. 159 has the letters C_1, C_2 &c., in wrong order and on p. 365 we have $(\theta-\theta)^{5/4}$ instead of $(\theta-\theta)^{5/4}$. These minor blemishes can easily be remedied in the next edition. We have no hesitation in heartily recommending this modern text to the attention of teachers and students of the Pass degree standard and we would also wish Honours students to go through the work if they want to obtain a clear grasp of the physical principles underlying the subject.

T. S. S.

The Arc Spectrum of Iron, FeI—Part I. By H. N. Russell and (Miss) C. E. Moore; and Part II. By (Miss) Weeks. *Transactions of the American Philosophical Society*, Vol. 34, Pt. II. (The American Philosophical Society, Philadelphia), 1944. Pp. 97. Price $2.25.

Eminent investigators have, from time to time, reviewed the state of our knowledge regarding the structure of the spectra of various elements; in one such recent survey, Dr. Shenstone has graded the then available knowledge of the arc spectrum of iron as 'B', where the letters 'A', 'B', 'C', 'D' are used to denote progressively incomplete knowledge. The iron arc is the source of most of the lines that have been chosen as secondary standards of wavelength, and the sun's spectrum contains numerous lines of iron. It was, therefore, a serious gap in our knowledge which was indicated by the letter B in Shenstone's survey. Now a veteran in the analysis of spectra—Dr. Henry Norris Russell—has filled the gap and raised the FeI spectrum to a grade better than 'A' by publishing the present monograph with the collaboration of Miss Moore and Miss Weeks. That other pioneer in the analysis of complex spectra—Dr. Catalan—has been responsible for much of the advance embodied in the monograph, and the authors say that his name would have figured as joint author but for the difficulties of postal communication in these times of international stress and strife. We can form a conception of the singular devotion of these investigators to the pursuit of knowledge when we realise that their interest in the spectrum of iron has remained unabated during decades despite the vicissitudes of peace and war. And when the authors say that the arc spectrum of iron still promises 'attractive' and 'remunerative' problems, we can appraise the significance of the adjectives in the light of their love of knowledge for its own sake. The lavish scale of American equipment for research is here exemplified by the results on the Zeeman effect of iron lines, studied by means of the great Bitter magnet producing 83000-87000 oersteds and Dr. Harrison's automatic measuring machine which prints on a film the wavelengths of lines to three decimals and also their intensities measured photoelectrically. The substantial advance embodied in the monograph can be seen from the fact that it lists 464 levels (while Goudsmit & Bacher's book gives 287), accounting for 3606 lines observed in laboratory sources and 1254 lines observed only in the solar spectrum, while the Zeeman effect of 1038 lines has been listed leading to 'g' values for 392 out of the 464 levels. Apart from the wealth of these data, there is the high accuracy, the average error of a level being only $\pm 0{\cdot}05$ cm.$^{-1}$ Stress must also be laid on the fact that grouping into term multiplets and assignment of electron configurations have been carried out almost exhaustively, with full details of the evidence for the correctness of the assignments. The ionisation potential is estimated at 7·858 volts. The terms, in spite of their numerousness, are found to accord with Hund's theory except for two levels designated X_2 and X_3 which seem to be difficult to reconcile with its predictions. As the authors say, not much remains to be done by way of analysis unless a new source is discovered, which can produce iron lines with a profuseness approaching that found in the sun.

The tables present one peculiarity, *viz.*, that the levels are listed according to parity and multiplicity and not according to energy values. Thus the even levels classified into singlets, triplets, quintets, septets, occur in this order and then the odd levels in a like order. From one point of view this is an advantage but the arrangement fails to show the importance of the various levels as being concerned in the emission of observable lines. The wavelength data extend from 11973 Å to 1855 Å, various sources having been laid under contribution. King's temperature classification has also been included.

In such an extensive mass of data so carefully compiled, it is idle to try and locate errors without detailed checking, but one or two obvious misprints that caught the eye of the writer may be mentioned. Thus in Table 7 on p. 118, the first column, first line has $n^* = 1{\cdot}3170$ while it should be 1·3130. In the second line the limit is given as 63630 while calculation gave it as 63610. In the third line, third column, Δn^* ought to be 1·0720 instead of 1·0723. In Table 10, p. 121, the number of ^{5}P terms to be expected is given as 6, and the number of ^{5}P terms observed is given as 7. This seems to show that more terms have been found than theory predicts, but the contradiction is not a real one. The number of ^{5}P terms assigned to the configuration concerned is, according to Table A, 6 and not 7, the 7th ^{5}P term being assigned to a different configuration.

Summing up we have no hesitation in saying that the paper is a model of what such work should look like, and that too a model worthy of close scrutiny but probably hard to imitate by anyone undertaking similar studies. Every practical spectroscopist should possess a copy of the paper and con over it time and again with the certainty of deriving profit each time from such a study. The price is probably not high for such literature.

T. S. S.

SCIENCE NOTES AND NEWS

Protection against Leeches.—Messrs. M. J. Narasimhan and M. J. Thirumalachar, Bangalore, write to us as follows:—

For people living in the tropical rain forest regions and plantation areas, leeches have been a source of trouble during wet weather and an uncontrollable source of worry to field workers. In the arecanut gardens and coffee plantations of Mysore, the workers and labour class suffer from leech-bites to a great extent resulting in bleeding and loss of blood and often suppuration of the wound. Many ingenious devices are taken against leech-bites such as tobacco, soap, lime solution, etc.; but, during the heavy monsoons owing to the splash of rain and slushy condition of the soil none of the precautions taken have proved really effective. The only effective way is to pick them off the leg and throw them away, but this leads to divided attention between work and leeches.

An ointment prepared by the School of Tropical Medicine, Calcutta (as reported in the *Plantens' Chronicle*, January 1, 1945) composed of 1 part of cinnamon oil and 7 parts of vaseline was found effective for 24 hours, but it has to be used with care, since it is an irritant to the mucous membrane.

The following preparation was given for trial to few members of Botanical excursions party, Central College, who recently went into a heavily leech-infested area. To 300 c.c. of hot castor oil or melted petroleum jelley, enough bees-wax is added to get the consistency of a paste on cooling. Just before this mixture hardens, 5 c.c. of pyridine (C_5H_5N) is added and stirred well to ensure thorough mixing up of the ingredients. The preparation is cooled and stored in well-stoppered bottles. For use, a small quantity of this paste is smeared on the surface of the boots or legs. It has been found that the leeches on approach, first get upon the boots and seem to get benumbed, for after a few seconds they drop on the ground falling as if in a stupor and do not recover for some time. When applied to bare feet, it does not seem to cause any irritation or injury to the skin at that concentration. Boots or shoes with a good coating of this paste (with higher concentration of pyridine if necessary) retain the repellant reaction for a fairly good number of days (as yet undetermined) and splashing through water or walking through slushy places does not in anyway appear to lower the repellent effect of the paste.

Mr. B. Krishnamurthy has asked us to insert the following:—

"The work of investigation published under the title 'Alternate media for large-scale rearing of the Rice-moth (*Corcyra cephalonica* St.) in the work of mass-production of the egg-parasite *Trichogramma minutum* R.,' in the October 1945 issue of *Current Science* was initiated by Mr. M. J. Narasimhan, Director of Agriculture in Mysore, who first suggested the use of Tapioca as the bulk food material in place of Jowar."

University of Bombay, Department of Chemical Technology.—The Annual Report for 1944-45 just received shows that two new sections of (1) Plastics, Paints and Varnishes, and (2) Oils, Fats and Soaps have started functioning from June 1945. "The Plastic Section will train graduates in chemistry in this new and increasingly important branch of technology, so that fully qualified personnel will be available for developing the Indian plastic industry. The object of the Oils Section is to assist the Indian fatty oil industry to expand in new directions and to utilise fully the fat resources of the country. The syllabuses provide for an adequate training in chemical engineering for the students of the two new sections."

During the year under review the construction of the buildings, and the equipment of the laboratories with gas, electricity, vacuum, etc., were completed, the laboratory plumbing, steam installations, and certain other items having been carried out departmentally.

A number of scholarships are awarded to the students by the Department (10), Sir Dorabji Tata Trust (5), and other charitable Trusts (10), and so also a large number of Fellowships for research.

Eleven original contributions were published during the year, and a number of others are ready for or awaiting publication. As usual a large number of papers deal with the chemistry of dyes, wetting agents, etc.; new lines of work are also reported on synthesis under high pressures and temperatures, and on foods and drugs.

Among the technical investigations completed may be mentioned the standardisation of natural indigo; as a result of numerous experiments, it has been possible to develop a process for preparing natural indigo in a standard form of uniform quality and strength. Other investigations deal with the suitability of electro-tin plate for storing hydrogenated oil, the examination of corrosion and scale formation in the boiler of one of the moffusil mills, etc.

Dr. Frans Verdoorn, Editor of *Chronica Botanica* and Botanical Adviser to the Board for the Netherlands Indies, writes that according to reports received from Holland, Australia and Java, the scientific institutions in the Buitenzorg area (West Java) are relatively in good condition. The classic collections in the herbarium, as well as the grounds of the famous Botanic Gardens at Buitenzorg, have not been damaged to any considerable extent (it also seems that herbarium material has not been transferred to Japan). The rich library of the Department of Economic Affairs and most of the experiment station buildings are also in tact. The following may be quoted from a letter from Dr. C. G. G. J. Van Steenis, the well-known authority on Malaysian botany, just received in the U.S.A.:—"I lost altogether one year work, but worked harder than in any other period ... finished several papers, and am almost ready with my

Cyclopædia of botanical collections, and book on Malaysian Plant-Life ... Was released as a prisoner of war, August 11, 1942, again in jail, December 14, 1942 to April 13, 1943, worked again to August 13, 1945. Now again interned ... The biologists, Dr. W. K. Huitema, Ir. P. H. Heckenberg, Dr. J. H. G. Ferman, Dr. M. P. Both, Ir. C. van der Giessen, and P. van der Groot, have died. Of many others, especially Dr. M. A. Donk, Dr. P. J. Eyma, and T. H. van der Honert, not yet any news. Dr. O. Posthumus, H. C. D. de Wit and my wife still working. Hope to be released soon ..."

National Institute of Sciences of India.—At a meeting of the Council of the National Institute of Sciences of India, held on Monday, the 19th November 1945, at the Delhi University, Delhi, the ballot papers were scrutinised and the following gentlemen were declared to have been elected Fellows of the Institute:—

Ordinary Fellows.—(1) Dr. I. Banerji, D.SC., Lecturer in Botany, Calcutta University; (2) Dr. P. B. Ganguli, D.SC., Principal, Science College, Patna; (3) Dr. S. Ghosh, D.SC., Professor of Chemistry, School of Tropical Medicine, Calcutta; (4) Dr. P. S. Gill, PH.D., Professor, Forman Christian College, Lahore; (5) Dr. J. C. Gupta, M.B., Professor of Pharmacology, School of Tropical Medicine, Calcutta; (6) Dr. S. S. Joshi, D.SC., Principal, College of Science, Benares Hindu University; (7) Dr. B. C. Kundu, PH.D., F.L.S., Professor of Botany, Presidency College, Calcutta, (8) Dr. C. Mahadevan, D.SC., Assistant Superintendent, Hyderabad Geological Survey, Hyderabad—Deccan; (9) Dr. P. C. Mahanti, D.SC., F.INST.P., Lecturer in Applied Physics, Calcutta University; (10) Dr. U. S. Nayar, M.A., PH.D., Head of the Department of Statistics, Travancore University, Trivandrum; (11) Dr. M. V. Radhakrishna Rao, M.B., B.S., PH.D., Clinical Research Officer, Haffkine Institute, Parel, Bombay; (12) Dr. M. L. Roonwal, PH.D., Assistant Superintendent, Zoological Survey of India, Benares Cantt.; (13) Dr. R. E. M. Wheeler, D.LITT., HON. D.LITT., Director-General of Archæology in India, Simla.

Honorary Fellows.—(1) Prof. A. F. Blakeslee, Smith College, Northampton, U.S.A.; (2) Dr. R. A. Millikan, President of the California Institute of Technology; (3) Prof. P. Niggli, Professor of Mineralogy and Petrology, Federal Polytechnical University and University of Zurich.

The Bombay Metallurgical Society.—A Society of the above name has been established at Bombay with 77 members, 11 associates and 18 firms engaged in metallurgical work, as subscribers.. *President*: Prof. N. P. Gandhi, formerly of the Benares Hindu University; *Secretary*: Mr. Y. M. Mehta, Partner, The Standard Plaster Works, Bombay. Those interested may obtain further particulars from the Secretary, Kennaway House, Proctor Road, Girgaon, Bombay 4.

The Meteorological Office Colloquium, Poona.—Mr. P. R. Pisharoti spoke on "The Theory of Cyclones" on 2nd and 9th November 1945, and Dr. R. Ananthakrishnan "On Fluctuations of pressure and temperature in the atmosphere" on 23rd and 30th November 1945.

SIR M. VISVESVARAYA, K.C.I.E., LL.D., has been re-elected unanimously as President of the All-India Manufacturers' Organization for the year 1946.

The Sixth Annual Conference of the All-India Manufacturers' Organization will be held on Friday, 28th, and Saturday, 29th December 1945, in Madras at the Banqueting Hall, Government House, under the Presidentship of Sir M. Visvesvaraya, K.C.I.E., LL.D. The first day's session starts at 3 p.m. on Friday, 28th December 1945. The Conference will have special importance in view of the fact that with the cessation of the war many vital transition problems connected with the industrialization of the country which are engaging the attention of the Government and the industrialists will be discussed.

Imperial Chemical Industries (India) Research Fellowship.—The Council of the National Institute of Sciences of India, Calcutta, has awarded an Imperial Chemical Industries (India) Research Fellowship, carrying a stipend of Rs. 400 per month, to Mr. Rama Nagina Singh, M.SC., to conduct research work on Algology under the direction of Dr. Yajnavalkya Bharadwaja, University Professor of Botany, Benares Hindu University, for two years in the first instance.

In 1938 the Burmah Oil Co., Ltd., embarked upon a large-scale survey, employing the latest known methods in the world, and at the outbreak of war, they had as many as seventeen separate geophysical parties at work in India and Burma. The survey had covered 330,000 square miles, 22,000 observation stations had been set up from which gravity measurements were made and the cost so far has been Rs. 45 lakhs. As soon as conditions permit, the B.O.C. are planning to employ the latest methods to try to find new oilfields. Amongst other companies, who engaged in oil exploration in India, is the Attock Oil Company.

ERRATA

Vol. 14, No. 9 (September 1945)

Page 229, Note on "Quantum Mechanical Theory of the Joshi Effect," column 1, line 21: *read* "ionised" *for* "isolated".

Page 245, Note on "Apparent Carotene and Vitamin C in Dehydrated Vegetables", in Table I heading, *read* "moisture-free basis" *for* "moisture basis".

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Page 261, Note on "A Relation between the Sheer Constant C_{44} ... Metals", column 2, last line of the table, under the heading ($r \times 10^8$ Calculated), the figure for K should be 4·87 in place of 8·87.

Page 276, Review of the book *A Class-Book of Botany*, para 2, line 15 (running on p. 277), *read* "petaloideæ" *for* "uitaloideæ".

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